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NEW SUPERFAMILY HAPLOPOROIDEA (SUBORDER ECHINOSTOMATA, SZIDAT, 1939 ; ORDER ECHINOSTOMIDA LA RUE, 1957 SYN. FASCIOLATOIDEA SZIDAT, 1936)

By

H. R. MEHRA*

[Received on 22nd September, 1961]

The families Haploporidae Nicoll and Waretrematidae Srivastava are closely related on account of preacetabular genital pore, single testis and a hermaphroditic sac containing vesicula seminalis interna, pars prostatica, ductus ejaculatorius, metraterm and ductus hermaphroditicus and thus constitute the new superfamily Haploporoidea. The families Magaperidae Manter, Haplosplanchnidae Poche, are closely related on account of similarity of life cycle and general resemblance in the cercariae which are biocellate and distomatous and simple tailed with lateral caudal lobes or notched lateral caudal fins. These cercariae possess cystogenus cells and lack cephalic glands, encyst in the open on vegetation and are eaten by herbivorous fishes as definitive hosts. The second intermediate host is absent in life cycle. The protonephrideal system of the cercariae is stenostomatous but the excretory vesicle containing concretions is Y-shaped in *Megapera* and small ovoidal in *Haplosplanchnus*. Haplosplanchnidae and Megaperidae lack hermaphroditic sac. The latter family parasitic in specialised marine fishes, the Plectognaths of different families, is specialised in certain characters such as large size of oral sucker and pharynx and presence of two ani. Haplosplanchnidae is specialised in having large acetabulum and single caecum. We include Haplosplanchnidae and Megaperidae in Haploporoidea n. supf. *Megasolenia* Linton, 1910 (Waretrematidae) in which two testes are present and excretory bladder is Y-shaped indicates primitive condition in contrast to that of other Haploporoidea. The hosts of this new superfamily except the Megaperidae belong to the species of the same family Mugilidae which according to Manter "serve as a sort of ecological bridge between trematodes of freshwater and marine fishes of coastal waters."

Diagnosis: Echinostomida, Echinostomata. Intestinal caeca single or double. Genital pore median or submedian, preacetabular. Testis single or double. Cirrus sac absent ; vesicula seminalis free. Hermaphroditic duct rudimentary or well developed, rarely absent. Hermaphroditic sac absent or present.

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Excretory bladder Y-shaped, tubular or saccular. Eggs large usually containing miracidia. Cercariae simple tailed possessing lateral caudal finger-like lobes *Haplosplanchnus*) or paired lateral notched caudal fins (*Megapera*) developing in sporocysts or rediae in marine snails and encyst in the open ; second intermediate host absent in life cycle. Parasitic in marine and freshwater fishes.

Families : 1. Haploporidae Nicoll, 1914.

2. Waretrematidae Srivastava, 1939.
   syn. Megasolenidae Yamaguti, 1942.
   syn. Megasolenidae Skrjabin, 1942.
3. Haplosplanchnidae Poche, 1925.
4. Megaperidae Manter, 1934.

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SYNERGISTIC ACTION OF NICOTINE WITH PYRETHRUM—I

By

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[Received on 6th October, 1960]

Very little attention has been paid to the studies on synergistic action of nicotine with pyrethrum. Synergism between nicotine and pyrethrum has been reported by Turner (1951). He applied each insecticide separately and the two insecticides together by injection into milkweed bugs. The degree of synergism was calculated by the method of Wadley (1954). Turner and Bliss (1953), while working with *Tribolium castaneum*, investigated the synergistic action of nicotine with pyrethrum. In the present work the experiments were conducted to investigate the following possibilities :—

Synergism between nicotine and pyrethrum :

(*i*) When mixed together.

(*ii*) On successive application.

(*iii*) If it acts as synergist on successive application, what role does the interval between two applications play ?

METHOD AND MATERIALS

Calandra granaria L. and *Calandra oryzae* L. reared in glass jars on wheat at constant temperature were used as test insects. In order to avoid any age effect nearly 10 days old insects were taken for all the experiments.

The general technique involved two operations :

(*a*) *Application of insecticides* : The following method (Blackith 1950) was employed for the application of insecticides. The insects to be treated, whilst confined within metal rings, were allowed to crawl over a thin film of the insecticide which was provided on a 7 cm. Whatman filter paper by impregnating it with 0·5 ml. solution. The inner walls of the rings were coated with paraffin to prevent the climbing of the weevils and were further covered by 7 cm. filter paper.

(*b*) *Assessment of toxic effect* : The response taken was the period of thanatosis, which was recorded after an incubation period of 24 hours, allowed after the treatment, to the insects. Necessity for the incubation period was felt for two reasons. Firstly, to let the insecticide penetrate the body and reach its site of action, after treatment. Secondly, to let the treated insects remain undisturbed for sometime before recording the duration of thanatosis as handling an insect shortly before stimulating it to feign death induces a state of excitement which may prevent its responding the stimulus. For recording the duration of thanatosis (Saxena, 1958*a*) the treated insects supplied with wheat grains were confined, individually, under the muslin topped metal rings, for 24 hours after the treatment. On expiry of this period, thanatosis was induced by applying a needle to the thorax. The termination time was taken on the movement of the antennae which indicated the end of death-feigning and the duration of thanatosis of each individual was recorded by the help of stop watch.

Experiments were performed with the adults of about the same age at 25°C ±1°C, R. H. 75%. The square root transformation was applied to the data to help to normalise the distribution of data and to make the variance in any group of observations more nearly independent of the mean.

DESIGN OF EXPERIMENT

A. *Synergism of nicotine mixed with pyrethrum* : The smaller range of doses of pyrethrum which were quite ineffective were used with *C. granaria.* In case of *C. oryzae* concentrations were selected which bring about three different changes in thanatosis durations (Saxena, 1958). The idea behind these experiments was to determine whether the mode of action of pyrethrum and nicotine is the same when applied separately or when applied jointly.

B. *Synergism of nicotine with pyrethrum on successive applications* : The following treatments were given to the weevils.

Insects were treated with, (*i*) pyrethrum followed by nicotine, (*ii*) nicotine followed by pyrethrum, and (*iii*) pyrethrum only.

C. *Synergism of nicotine applied prior to pyrethrum with different intervals between applications* : After an investigation of nicotine treatment followed by pyrethrum, the question arises, how does the interval between the applications of the insecticides affect nicotine as synergist. 4 experiments with *C. granaria* and 3 with *C. oryzae* were performed with intervals of ½, 3, 6 and 12 hours and ½, 6 and 12 hours, respectively between the treatments.

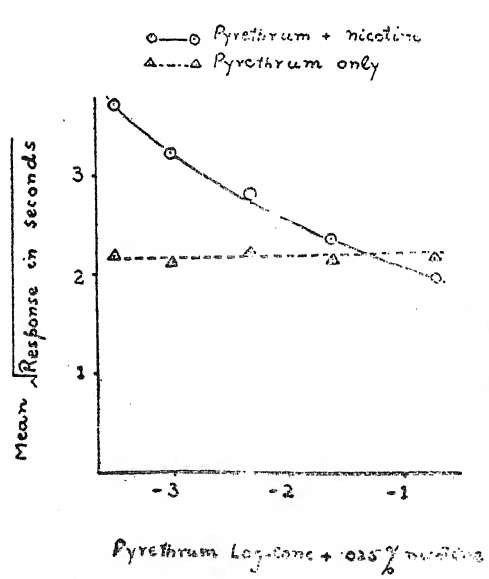

Fig. 1. Thanatosis response of *C. granaria* to pyrethrum and pyrethrum + nicotine.

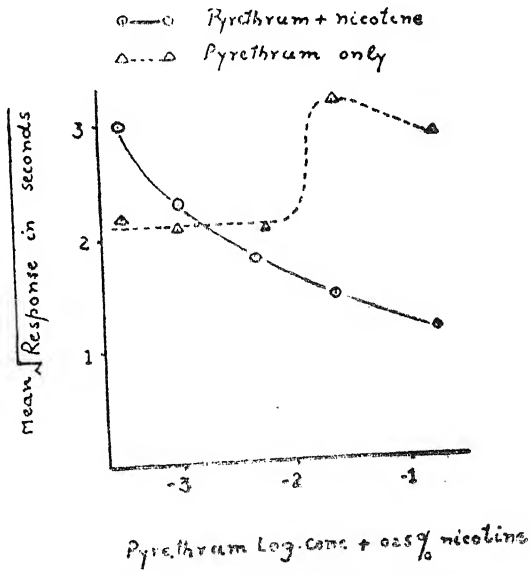

Fig. 2. Thanatosis response of *C. oryzae* to pyrethrum and pyrethrum + nicotine

RESULTS

The low doses of pyrethrum were selected so that they should have practically no effect on the duration of thanatosis in the case of *C. granaria.* A remarkable change in the period of thanatosis occurred when pyrethrum mixed with ·05%

nicotine in the ratio of 1 : 1 was used for treatment. ·05% nicotine has no effect on thanatosis (Saxena, 1958). The periods of thanatosis were either increased or decreased according to the concentrations of the insecticides, (Figs. 1 and 2).

On treating the insects with pyrethrum followed by nicotine, no considerable change in the duration of thanatosis was recorded compared with that of the insects subjected to pyrethrum only. On the other hand the periods of thanatosis of weevils of both the species treated with nicotine followed by pyrethrum were either increased or decreased, according to the concentrations of pyrethrum applied (Figs. 3 and 4).

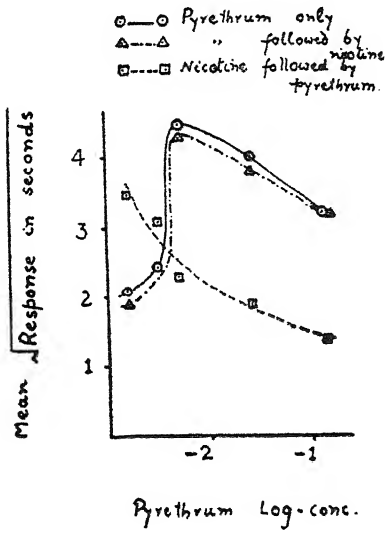

Fig. 3. Thanatosis response of *C. granaria* to pyrethrum and pyrethrum and nicotine applied successively.

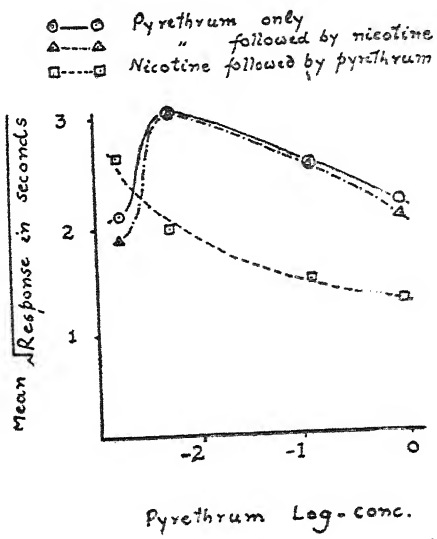

Fig. 4. Thanatosis response of *C. oryzae* to pyrethrum and pyrethrum and nicotine applied successively.

It is interesting to note that the maximum change in the duration of thanatosis occurred when the interval between treatments was ½ hour (Figs. 5 and 6). On increasing the interval the periods of thanatosis either increase or decrease and move towards the normal values. The granary weevils which were paralyzed by treatment with ·06% pyrethrum applied after ·05% nicotine, with ½ hour interval allowed between the two treatments, were able to metabolize the insecticide absorbed during treatment at the same concentration as when the interval was increased to 12 hours. Similarly the paralyzing action of treatment with ·08% and ·1% pyrethrum applied after ·05% nicotine, with ½ hour interval between treatments, was reduced when an interval of 12 hours was allowed. ·2% and ·4% pyrethrum applied after ·05% nicotine was able to paralyze the insects when the interval between the treatments was 12 hours, but to a lesser degree than when it was ½ hour (Figs. 5 and 6).

The symptoms shown by the insects treated with pyrethrum plus nicotine and with nicotine followed by pyrethrum at an interval of ½ hour between the treatments were similar to those shown by the insects treated with the higher pyrethrum doses than used *i.e.* tremor of the legs, zig zag locomotion etc.,

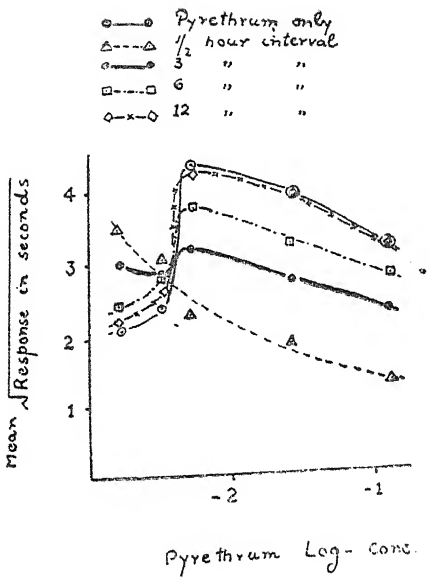

Fig. 5. Thanatosis response of *C. granaria* to nicotine followed by pyrethrum with different intervals in between the treatments.

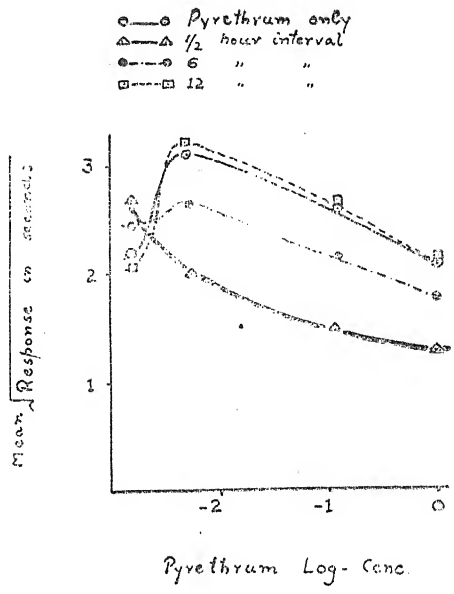

Fig. 6. Thanatosis response of *C. oryzae* to nicotine followed by pyrethrum with different intervals in between the treatments.

DISCUSSION

A considerable change in the period of thanatosis (Figs. 1 and 2) has been recorded on subjecting the insects to a mixture of nicotine and pyrethrum, whereas normal duration was shown by the insects treated with pyrethrum and nicotine separately at the same concentrations. The effect on the duration of thanatosis was obviously due to an increase in potency of the pyrethrum. It is interesting to note that symptoms such as tremor of legs and in co-ordinate locomotion, which are exhibited by the insects treated with high concentrations of pyrethrum and not by those treated with nicotine (Saxena, 1958), were shown by the insects which were subjected to a mixture of nicotine and pyrethrum. Hence the important conclusion which could be drawn from the results is that nicotine mixed with pyrethrum increases the toxicity of the latter and thereby acts as a synergist. Turner (1951) investigated the synergistic effect of nicotine when mixed with pyrethrum by expected and observed mortality.

Later some experiments in the present work were conducted by applying nicotine and pyrethrum successively. The curve drawn (Figs. 3 and 4) for pyrethrum applied prior to nicotine coincides with the curve drawn for pyrethrum only—showing that the effect on the insects in both the treatments was identical, whereas a considerable change in the duration of thanatosis and an altogether different curve was obtained when the treatment of nicotine was followed by a pyrethrum treatment with an interval of half an hour between the two treatments. These results suggest that there is no increase in the toxicity of pyrethrum when its application is followed by nicotine whereas the toxicity increases when pyrethrum is applied to nicotine-treated insects. Turner's (1951) suggestion that nicotine conditions the insects so that they are more susceptible to pyrethrum may be right, but it requires further investigation. Lindquist, Madden and Wilson

(1947) suggested that the synergist may cause slight injury or disarrangement to nerve or other tissues so that the pyrethrum applied later is more effective in producing knockdown. The same authors (1947) found that the synergists sesame oil, piperonyl cyclohexanone and N– Isobutylundecylenamide applied to houseflies increased the toxicity of pyrethrum applied an hour later, but when the application of pyrethrum was followed by the synergist an hour later, toxicity was very low. Their suggestion that the effect of pyrethrum on the insects was of short duration, led me to apply nicotine followed by pyrethrum with different intervals, in the present work. Intervals of ½, 3, 6 and 12 hours were employed. The greatest effect on the insects was observed at ½ hour interval between the treatments, whereas the synergistic effect declined steadily as the time between the treatments was increased and no synergism was noticed at 12 hours interval. (Figs. 5 and 6). Similar results were obtained by Turner (1951) and Turner and Bliss (1953), who observed the complete disappearance of the synergistic effect of nicotine at an interval of 6 hours. The hypothesis of Lindquist, Madden and Wilson (1947) that due to the shorter duration of the effect of pyrethrum on these insects, no synergism was observed when pyrethrum was applied an hour before the treatment with synergist, does not appeal to me as the duration of the toxic effect of pyrethrum (Saxena, 1958) does not appear to be as short as ½ hour. Turner and Bliss (1953) suggested that the poisons differed in speed of penetrating the cuticle and reaching a site of toxic action, and the difference may be responsible for the relation between toxicity and time interval between applications. In the previous experiments with nicotine it was observed that the nicotine-treated insects recover quickly if left for a short period in the open air, hence the author inclines to believe that the shorter duration of the effect of nicotine may be the cause of a decline in the synergistic effect of nicotine, when the interval between the treatments of nicotine and pyrethrum is increased.

Further information from these tests indicates that the magnitude of synergism between nicotine and pyrethrum, when applied in a mixture is higher than when pyrethrum is applied to nicotine treated insects after an interval of half an hour.

SUMMARY

Nicotine, when added to pyrethrum, increases the toxicity of the later. It does not act as a synergist if applied to pyrethrum-treated insects whereas synergism was observed when pyrethrum was applied to insects half an hour after they had been treated with nicotine. The synergistic effect declines steadily as the interval between the treatments with nicotine and pyrethrum is increased. The effect completely disappears if the interval is 12 hours or longer between treatments. It is quite likely that the shorter duration of the toxic effect of nicotine might be the cause of the disappearance of the synergistic effect.

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to Prof. O. W. Richards for his kind permission to work at Imperial College Field Station Sunninghill, Berks., England. He is also indebted to Dr. A. B. P. Page for his valuable advice and constant supervision and to Dr. R. E. Blackith for his helpful suggestions throughout the investigation. His thanks are also due to Prof. D. S. Srivastava Professor and Head of Zoology Deptt. University of Sagar for his help in preparing the manuscript of this paper.

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STUDIES ON NUTRITION OF *CURVULARIA PENNISETI* MITRA (BOED.).

1. THE INFLUENCE OF SOME SOURCES OF CARBON AND NITROGEN ON ITS GROWTH AND SPORULATION

By

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[Received on 26th June, 1961]

Agarwal (1955) made some investigations on the nutrition of *Curvularia penniseti*. He studied the effect of various sources of carbon and nitrogen on the growth and sporulation of the above organism but he included a few substances only. This paper deals with the influence of some other carbon and nitrogen compounds on the growth and sporulation of that pathogen.

MATERIAL AND METHODS

The fungus was isolated from the infected leaves of *Pennisetum typhoideum* Stapf. and Hubb. collected from various local fields. Usual methods of isolation were followed. Pyrex glasswares and chemicals of highest purity were used. The pH of all the media was adjusted to 5·4. Twenty five cc. of liquid media were taken in 150 cc. conical flasks. Four replicates were used for each treatment. The media, except those containing such compounds which break up on autoclaving (which were fractionally sterilized), were autoclaved at 15 lbs. pressure for 15 minutes. After inoculation they were incubated at 25°C for 15 days. The fungal mats were then harvested on previously dried and weighed Whatmans' filter papers. They were dried at 65°C for two days and were subsequently transferred to a dessicator. After cooling they were quickly weighed and the dry weight was calculated. The average weight of the four replicates was used as a quantitative measure for the growth of the fungus on different media.

Asthana and Hawker's medium A* was used as basal medium. In order to study the effect of various carbon compounds the amount of carbon in glucose of the basal medium (*viz.*, 2 gms. of carbon) was calculated and it was replaced by equal quantity of carbon in the carbon sources used in the present investigation. Similarly in order to study the effect of various nitrogen compounds they were singly substituted for potassium nitrate of the basal medium. The quantity of different compounds was so adjusted as to contain an amount of nitrogen present in 3·5 gms. of potassium nitrate. Following compounds were tried :

Carbon Compounds :

1. Monosaccharides :
   - (*a*) Pentose : Xylose
   - (*b*) Hexose : Fructose and sorbose.
2. Polysaccharides :
   Dextrin, inulin.

*5 gms. glucose, 3·5 gms. potassium nitrate, 1·75 gms. potassium dihydrogen phosphate, 0·75 gms. magnesium sulphate, 1·0 litre of distilled water.

3. Alcohols :
   Sorbitol, glycerol.

4. Acids :
   Malic acid, tartaric acid.

Nitrogen Compounds :

1. Inorganic compounds :
   Calcium nitrate, magnesium nitrate, potassium nitrite, ammonium carbonate.

2. Organic compounds :
   (*a*) Monoamino monocarboxylic acid :
   dl. leucine, dl. phenylalanine, dl. valine.
   (*b*) Monoamino dicarboxylic acid :
   l. glutamic acid.
   (*c*) Basic amino acid :
   l. histidine, l. arginine.
   (*d*) Amines :
   Thiourea.

Besides these, media were also prepared without addition of carbon or nitrogen.

Observations :

The dry weight, sporulation and spore size of *Curvularia penniseti* on different carbon and nitrogen compounds are recorded in tables 1 and 2 respectively.

TABLE 1

Showing dry weight in mgs., sporulation and spore size of *Curvularia penniseti* on media containing 2 gms. of carbon in different carbon compounds.

No.	Carbon compounds	Dry weight in mgs.	Sporulation*	Spore size in μ
1.	Xylose	27·3	Poor	28·2×12·4
2.	Fructose	79·2	Good	31·4×13·6
3.	Sorbose	14·2	Poor	30·1×12·2
4.	Inulin	37·2	Good	32·2×14·1
5.	Dextrin	44·8	Good	29·2×13·5
6.	Sorbitol	37·3	Poor	28·4×12·6
7.	Glycerol	00·0	—	—
8.	Tartaric acid	00·0	—	—
9.	Malic acid	10·8	Absent	—
10.	No carbon	00·0	—	—
	Average=25·0			

*Number of spores in low power field of microscope		Sporulation grade
Nil	. .	Absent
1—10	. .	Poor
11—20	. .	Fair
21—30	. .	Good
Above 30	. .	Excellent

Summary of dry weight results and conclusions at 5% level of P.

Treatments	. . .	Highly significant
Replicates	. . .	Non-significant
S. E.		C. D. at 5% level.
1·538		4·57

Dry weight results in mgs.

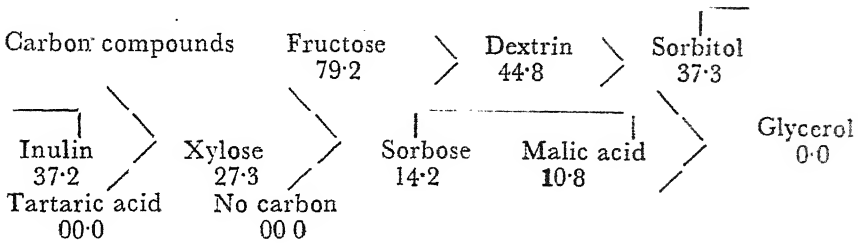

TABLE 2

Showing dry weight, sporulation, and spore size of *Curvularia penniseti* on media containing equivalent quantities of different nitrogen compounds.

No.	Carbon compounds	Dry weight in mgs.	Sporulation	Spore size in μ
1.	Calcium nitrate	59·1	Excellent	29·1 × 12·2
2.	Magnesium nitrate	53·6	Excellent	31·2 × 12·4
3.	Potassium nitrite	00·0	—	—
4.	Ammonium carbonate	45·4	Good	28·4 × 13·1
5.	dl. Leucine	40·8	Poor	28·1 × 12·2
6.	dl. Phenylalanine	42·2	Poor	29·3 × 12·4
7.	dl. Valine	51·1	Good	29·4 × 14·3
8.	l—Glutamic acid	41·7	Poor	28·6 × 12·3
9.	l—Histidine	48·4	Poor	29·2 × 12·2
10.	l—Arginine	49·6	Poor	30·1 × 12·2
11.	Thiourea	53·4	Poor	27·3 × 12·1
12.	No nitrogen	00·0	—	—
	Average=40·3			

Summary of dry weight results and conclusions at 5% level of P.

Treatments	. .	Highly significant
Replicates	. .	Non-significant
S. E.		C. D. at 5% level
1·647		4·83

Dry weight results in mgs.

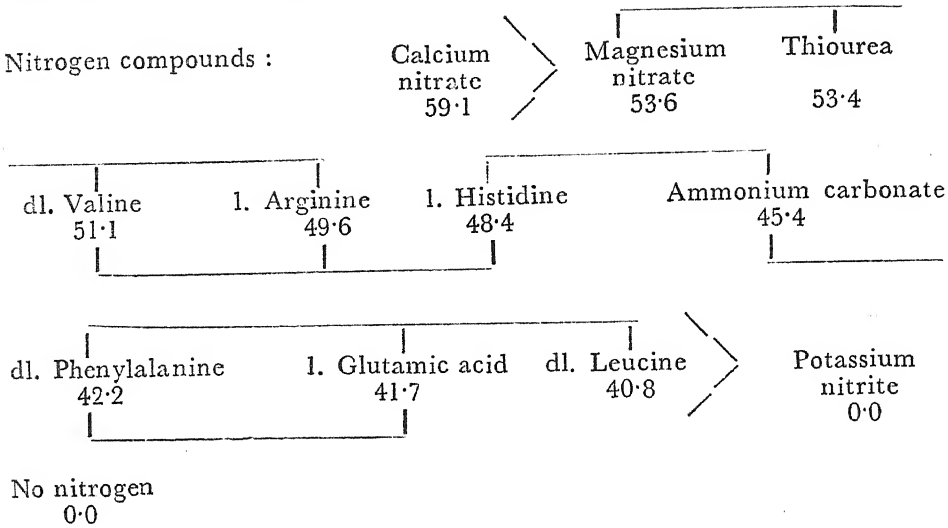

Table 1 shows that *Curvularia penniseti* could grow on all the compounds used except on glycerol and tartaric acid. It was incapable of growing in a medium lacking any carbon source. Significantly good growth was obtained on fructose, dextrin, sorbitol and inulin. The growth on sorbose and malic acid was poor while it was moderate on xylose. The same table also shows that sporulation varied with the source of carbon. Xylose, sorbose and sorbitol induced poor sporulation. Good sporulation was obtained on fructose, inulin and dextrin. Malic acid completely inhibited the development of spores.

It is clear from table 2 that the present organism was able to assimilate nitrogen from nitrates, ammonium carbonate and organic compounds included in the present investigation. There was no growth on potassium nitrite. The growth on dl. phenylalanine, l. glutamic acid and dl. leucine was moderate while on the rest of the compounds it was significantly good. No growth was obtained in the absence of nitrogen. The same table also shows that different nitrogen sources had different effect on the sporulation of *Curvularia penniseti*. Excellent sporulation was produced on calcium nitrate and magnesium nitrate. Ammonium carbonate and dl. valine induced good sporulation. The sporulation on others was poor.

It may be mentioned that there was some correlation between growth and sporulation on a number of carbon and nitrogen compounds used. This relation was very clear on fructose, dextrin, inulin, magnesium nitrate, calcium nitrate, dl. valine and ammonium carbonate which gave good growth and good sporulation. It was also clear on sorbose, which was a poor source of carbon for both growth and sporulation.

Variation in the carbon or nitrogen source of the medium had no pronounced effect on the size of the spores.

DISCUSSION

The essentiality of carbon and nitrogen for the present organism was shown by the absence of growth in the media lacking any of them. The present organism

was capable of assimilating carbon and nitrogen from most of the compounds used.

Amongst the carbohydrates, xylose, the only pentose used in the present investigation was found to be a moderate source for growth. The two hexoses *viz.*, fructose and sorbose were quite different in their behaviour as fructose supported good growth while sorbose was found to support only poor growth. Good growth on fructose was also reported by a number of investigators including Durairaj (1956), Matsushima and Klüg (1958) and Das Gupta and Shome (1960). Sorbose has generally been reported to be a very poor carbon source but Pisano and Plucker (1958) found it to be a good source for *Cephalosporium longisporum* and thus their organism differed from present pathogen. Both the polysaccharides were good for the growth of *Curvularia penniseti*. Similar results have been obtained by Wolf (1953), Crasemann (1957) and Matsushima and Klüg (1958) for *Ustilago zeae*, *Blastocladia ramosa* and *Ustilago maydis* respectively. Sorbitol differed from glycerol as the former supported poor growth of the fungus while latter completely inhibited the growth. Brock (1951), Mehrotra (1951) and Matsushima and Klüg (1958) have also reported poor growth of their organisms on sorbitol. Agarwala (1955), however, reported good growth of *Gloeosporium psidii*, *G. limetticolum* and *G. citricolum* on sorbitol and thus his organisms differed from *Curvularia penniseti*. Malic acid supported poor growth while no mycelial growth was observed on tartaric acid. Poor response of organic acids has also been reported by Leben and Keitt (1948) and Bilgrami (1956) for *Venturia inaequalis* and *Phyllosticta artocarpina* respectively.

Both calcium nitrate and magnesium nitrate were found to be good sources of nitrogen for the growth of *Curvularia penniseti*. Nitrates have also been reported to be good by Durairaj (1956), Leaphart (1956) and Misra and Mahmood (1960) for the organisms studied by them. Potassium nitrite inhibited the growth of the present organism. Similar results have been obtained by Leben and Keitt (1948) Gordon (1950), Patel *et. al.* (1950) and Thind and Randhawa (1957). Though generally nitrite nitrogen is considered toxic to fungi but *Rhizopus oryzae* (Lockwood *et. al.* 1936), *Hormodendrum resinae* (Marsden 1954), *Ceratocystis pilifera* (Leaphart 1956) and *Fusarium coeruleum* (Tandon and Agarwal 1957) could grow on nitrites. Ammonium carbonate supported good growth of *Curvularia penniseti* and in this respect it was similar to *Pestalotia mangiferae* (Bilgrami 1956) which also gave good growth on this substance.

Amongst amino acids dl. leucine was found to be a moderate source of nitrogen for the growth. Thus the present organism differed from *Ustilago zeae* (Wolf 1953), *Colletotrichum capsici* (Thind and Randhawa 1957) and *Trichophyton rubrum* (Das Gupta and Shome 1960) all of which gave good growth on this substance. Sakai (1959) reported dl. phenylalanine to be a good nitrogen source for the growth of *Phytophthora infestans* and thus his organism differed from *Curvularia penniseti* which gave only moderate growth on this source. Good growth of the present organism was obtained on dl. valine, which has also been reported to be a good source of nitrogen for the growth of *Gloeosoporium limetticolum* (Agarwala 1955), *Ceratocystis pilifera* (Leaphart 1956), *Gloeosporium musarum* (Tandon and Grewal 1956) and *Colletotrichum capsici* (Thind and Randhawa. 1957). Glutamic acid supported moderate growth of *Curvularia penniseti*, which, therefore, differed from *Diplocarpon rosae* (Shirakawa 1955) and *Isaria cretacea* (Taber and Vining 1959) which gave poor and good growth respectively.

Both histidine and arginine could support good growth of the organism included in the present investigation. Histidine was found to be a good nitrogen source for the growth of *Ustilago zeae* (Wolf 1953) as well as for *Phyllosticta cycadina*

(Tandon and Bilgrami 1954). Sakai (1959), Hall (1959) and Das Gupta and Shome (1960) obtained good growth of their organisms on arginine and thus their fungi resembled the present one. Taber and Vining (1957) obtained good growth of *Claviceps purpurea* on thiourea and in this respect *Curvularia penniseti* was similar to this organism.

Many investigators have reported that the kind of carbon or nitrogen compound in the medium influenced the sporulation. *Colletotrichum lindemuthianum* (Mathur *et. al.* 1950) produced good sporulation on galactose and glucose but poor on mannose and mannitol. Misra and Mahmood (1960) reported good sporulation of *Colletotrichum capsici* on potassium nitrate, calcium nitrate but only poor sporulation on ammonium nitrate. In the present investigation also it was found that the sporulation varied with different carbon and nitrogen sources. There was some correlation between growth and sporulation on a number of compounds as in such cases, both growth and sporulation was either good or poor. In general fructose, dextrin, inulin, calcium nitrate, magnesium nitrate and dl. valine were good sources for the growth and sporulation.

SUMMARY

The growth and sporulation of *Curvularia penniseti* on a number of different sources of carbon and nitrogen has been worked out. The organism could grow on all the carbon compounds used except tartaric acid and glycerol. It was found that all the nitrogen sources except potassium nitrite were assimilated by the organism under investigation. Both carbon and nitrogen were found to be essential for the growth, as no growth was obtained on media lacking those substances. The source of carbon or nitrogen excercised a profound effect on the sporulation of the fungus. There was some correlation between growth and sporulation on a number of carbon and nitrogen compounds.

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SULPHUR REQUIREMENTS OF SOME MEMBERS OF THE FAMILY SAPROLEGNIACEAE*

By

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INTRODUCTION

Sulphur is found both in organic and inorganic form in a large number of compounds. Generally sulphate sulphur (SO_4) is used in the preparation of media. However, there are some fungi which require specific form of organic sulphur for their growth. Volkonsky (1933, 1934) observed that some of the aquatic phycomycetes such as *Achlya prolifera, A. polyandra, A. oblongata, A. conspicua. Dictyuchus monosporus, Isoachlya monolifera, Saprolegnia parasitica*, and *Aphanomyces* failed to utilize sulphate sulphur. The work of several other investigators, also proves that saprolegniaceous fungi are unable to utilize sulphates but readily take up cystin and sulphides. Volkonsky (1. c.) reported that these saprolegniaceous fungi thrive best on organic sulphur but thiosulphates and sulphides can also be utilized to some extent.

The importance of sulphur in the nutrition of fungi has been demonstrated by various workers such as Kossowiez and Loew (1912) Armstrong (1921), Rabinovitzsereni (1933), Volkonsky (1933, 1934), Bhargava, (1945) Saksena *et al* (1952). The present investigations were taken up in order to find out suitable sources of sulphur compounds (both inorganic and organic) for the growth of present saprolegniaceous fungi.

MATERIALS AND METHODS

The organisms selected for the study were *Achlya aplanes Maurizio, Isoachlya unispora* Coker and Couch, *I. toruloides* Kauffman and Coker, *Saprolegnia parasitica* Coker. Various sulphur compounds were added singly to the basal medium** so as to furnish 25 mgm. of sulphur per litre. The various media were autoclaved at 15 lbs. pressure for 15 minutes. The pH of the media was adjusted to 7·0 before autoclaving and the flasks were incubated for 15 days at 25°C (± 1°C).

EXPERIMENTAL

The results are summarised in Table 1.

A critical examination of Table 1 shows that *Achlya aplanes, Isoachlya unispora. I. toruloides* and *Saprolengnia parasitica* were unable to utilize sulphur in the form of sulphates, sodium bisulphite, sodium bisulphate and potassium persulphate. Of the inorganic compounds tried, sodium thiosulphate supported the maximum growth of *Achlya aplanes* and *Saprolegnia parasitica* while sodium sulphide was the best for the two species of *Isoachlya.* Among the organic compounds thiourea

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**KH_2PO_4—0·5 gm., $Mgcl_2$—$6H_20$·0·5 gm., NH_4NO_3—2·0 gm., dextrose 5·0 gm., and distilled water 1,000 ml.

proved to be the best source for the growth of *Achlya aplanes* and *Saprolegnia parasitica*, while cystin was best for *Isoachlya unispora* and *I. toruloides*. Control did not support the growth of any of the fungi tried.

TABLE 1

Showing dry weight (in mgm.) of the four fungi on media containing equivalent quantities of different sulphur compounds

Sulphur compounds	FUNGI			
	Achlya aplanes	*Isoachlya unispora*	*Isoachlya toruloides*	*Saprolegnia parasitica*
Potassium sulphate	0·0	0·0	0·0	0·0
Ammonium sulphate	0·0	0·0	0·0	0·0
Magnesium sulphate	0·0	0·0	0·0	0·0
Zinc sulphate	0·0	0·0	0·0	0·0
Sodium thiosulphate	18·0	13·4	12·0	32·0
Sodium sulphide	15·3	19·6	20·6	21·0
Sodium bisulphite	0·0	0·0	0·0	0·0
Sodium bisulphate	0·0	0·0	0·0	0·0
Potassium persulphate	0·0	0·0	0·0	0·0
Thiourea	13·4	12·0	13·4	18·0
Cystin	10·4	16·7	13·7	17·7
Control	0·0	0·0	0·0	0·0

DISCUSSION

The results obtained during the present studies of *Achlya aplanes*, *Isoachlya unispora*, *I. toruloides* and *Saprolegnia parasitica* are in agreement with those obtained by Volkonsky (1934) for some members of the family Saprolegniaceae. He reported that the fungi employed by him were unable to assimilate sulphates, but used thio-sulphates, sulphydryl or sulphides.

All of the fungi were incapable of utilizing sulphur from sodium bisulphite, sodium bisulphate and the results obtained are in accord with the findings of Bhargava (1945) who reported that saprolegniaceous fungi studied by him also could not utilize these compounds.

Potassium persulphate has been reported as a poor source for some species of *Pythium* by Saksena *et al* (1952), by Bhargava (1945) for some members of the family Saprolegniaceae. The fungi studied by the author are similar in behaviour to those mentioned above.

Thiourea was found to be a good source of sulphur for all the present organisms. On the other hand, this compound has been reported as a poor source of sulphur for some members of the family Saprolegniaceae (Bhargava, 1945). The present results, however, differ with the findings of above authors in this connection.

The fungi investigated by the author showed good growth on cystin and in this respect resembled *Pythium arhenmanes* investigated by Saksena *et al* (1952). Bhargava (1945) also reported that cystin was a good source for the growth of some members of the family Saprolegniaceae.

The fact that sulphur is essential for the growth of the organisms is evident by the absence of growth in control (medium lacking in a sulphur source).

SUMMARY

1. The sulphur requirements of *Achlya aplanes*, *Isoachlya unispora*, *I. toruloides* and *Saprolegnia parasitica* were studied. It was found that these fungi could not utilize sulphur from sulphates, sulphites, bisulphites, bisulphates, persulphates but grew best on media containing sodium sulphide and sodium thiosulphate as sources of sulphur.

2. They were able to employ organic sulphur in the form of thiourea and cystin.

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*Original not consulted.

TRIAL WITH DIFFERENT INSECTICIDES ON THE CONTROL OF *PLUSIA ORICHALCEA* FABR. CATERPILLARS (NOCTUIDAE : LEPIDOPTERA) ON LOBIA CROP

By

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INTRODUCTION

The green semi-looper caterpillars of *Plusia orichalcea* Fabr. cause severe damages to green foliage of leguminous crops particularly pea and lobia. They feed so voraciously that in the case of a severe infestation, the whole crop is invariably defoliated of its green vegetation in a single night. Thus the farmer is taken unawares and is, therefore, robbed of his wealth. Hexidole 805 dust is recommended for its control but it does not give very satisfactory result. Tests were made with four different insecticides, 5% BHC dust, 0·125% Endrin emulsion, 0·25% DDT emulsion and 0·25% BHC+DDT wettable powder, with a view to find out their relative efficacy against this pest on lobia (*Vigna* sp.) crop. The results of the experiment are presented here.

CHARACTERS OF THE MOTH

Adult : The colour of the head, collar, and thorax is reddish orange. The palpi are turned upwards and its second segment reaches the vertex of the head. The antennae are ciliated in males. Thorax bears a large tuft of spreading hairs on the vertex. Tegulae and fore wings are pale red brown in colour. The whole of the outer area of fore wing, except the inner margin, is occupied by a brassy golden patch which extends towards the base below median nervures. The sub-basal, antemedial and post-medial lines are wavy, white and very indistinct, and the sub-marginal line is irregularly lunulate. Hind wing is pale at the base, its outer area being fuscous. Dorsally, the abdomen bears three large tufts of hairs on the basal segments. The lateral abdominal tufts and the anal tufts are more developed in male than in the female.

Larva : The caterpillars are bluish green in colour, and each is provided with two pairs of abdominal prolegs. White lines are faintly indicated on the dorsal side of the body whereas laterally the body shows a prominent lateral line.

EXPERIMENTAL DETAILS

The experiment was performed in a farmer's field at Allahabad in a non-replicated manner in five equal sized plots, each one measuring 60×180 sq. feet. Population of the caterpillars was counted before the treatment by using a square wooden frame measuring one foot each side, and putting it at several places in the plot. The caterpillars found within the area covered by the frame were counted and the reading taken. The population* of the caterpillars per 100 sq.

*In order to get integral numbers, the average population of the caterpillars has been given per 100 sq. feet area.

feet before the application of the insecticide was found to be 880 in plot A, 830 in plot B, 900 in plot C, 850 in plot D, and 800 in plot E. (Table 1).

Five pounds of 5% BHC dust (Hexidole 805) was dusted with a hand-driven dusting machine at the rate of 20 lbs. per acre in plot A. 0·125% Endrin emulsion, 0·25% DDT emulsion, and 0·25% BHC+DDT wettable powder were applied in the form of a spray with a knap-sac "Calimax" Sprayer at the rate of 40 gallons per acre in plots B, C, and D, respectively. The actual amount of the insecticide used was 10 ozs. of Endrin 20% emulsion concentrate, 1 lb. of DDT 25% emulsion concentrate, and 1/2 lb. of BHC+DDT 50% wettable powder, each mixed separately with 10 gallons of water to form the spray. The plot E was left untreated to serve as control plot. All the operations were conducted the same day taking minimum possible time. The population of the caterpillars in all the plots was again noted after 72 hours of the treatment in the same way as before the application of the insecticides.

The results of the experiment have been based on 45 sq. feet area examined per plot and the corrected mortality has been calculated using the following formula :

$$\text{Corrected mortality} = \frac{(\text{Mortality in Treatment} - \text{Mortality in Control}) \times 100}{100 - \text{Mortality in Control}}$$

TABLE 1

Plot number	Treatment	Population of caterpillars per 100 sq. feet before treatment	Population of caterpillars per 100 sq. ft. 72 hrs. after the treatment	% Mortality (Not corrected)	% Mortality (corrected)	Cost of the insecticide used per acre
A	BHC dust 5%	880	50	94·1	91.5	Rs. 3·00
B	Endrin spray 0·125%	830	4	99·5	99·3	Rs. 18·80
C	DDT spray 0·25%	900	9	99·0	98·5	Rs. 8·80
D	BHC+DDT wettable powder 0·25%	850	40	95·3	93·2	Rs. 1·64
E	Control	800	550	30·9	. .	. .

RESULT AND DISCUSSION

From the table it is evident that 0·125% Endrin emulsion spray and 0·25% DDT emulsion spray give nearly 100% control*, whereas, 5% BHC dust and 0·25% BHC+DDT wettable powder give 91·5% and 93·2% mortality respectively. The working cost per acre of each insecticide used has been calculated at Rs. 3·00 for 5% BHC dust, Rs. 18·80 for 0·125% Endrin emulsion, Rs. 8·80 for 0·25% DDT emulsion and Rs. 1·64 for 0·25% BHC+DDT wettable powder.

*To be precise, Endrin and DDT spray gave 99·3% and 98·5% mortality respectively, but for practical purposes it is regarded as 100%.

It is, therefore, concluded that 0·25% BHC+DDT wettable powder is cheapest amongst all the insecticides used and it also gives better control than 5% BHC dust which has been in extensive use so far against this pest. 0·125% Endrin emulsion and 0·25% DDT emulsion are economically impracticable because their cost per acre is very high.

SUMMARY

The comparative effect of four insecticides, 5% BHC dust, 0·125% Endrin emulsion, 0·25% DDT emulsion and 0·25% BHC+DDT wettable powder, has been studied against the semi-looper caterpillars of *Plusia orichalcea* Fabr. attacking the lobia (*Vigna* sp.) crop. 0·25% BHC+DDT wettable powder gave better control than 5% BHC dust which is, so far, the most recommended and widely used insecticide against this pest. The use of 0·25% BHC+DDT wettable powder is economically advantageous also because the working cost per acre of this insecticide is least of all the insecticides tried.

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SEMINAL ROOTS OF GRASSES

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INTRODUCTION

Grasses develop a crown of fibrous roots often distinguishable as seminal and nodal root systems at seedling stages. Seminal root system consists of a small number of main roots and their branches which feed the seedling for a time after germination and these originate from initials in the seed (Guttenberg, Heydel and Pankow 1954) while nodal roots arise endogeneously from the stelar tissue of the nodes on the stem (Goossens 1936), either a true stem, a rhizome or a stolon (Arber 1934). A knowledge of seminal root behaviour is essential before any pasture trials by seed mixtures are attempted, since seminal root extension and persistence forms an early phase of grass seedling establishment on fresh habitats. Hence an experimental study of seminal root longevity and extent for five perennial grasses is presneted here for promotion of seed sown pastures in India.

REVIEW OF LITERATURE

Growth of seminal roots is visibly studied in special glass containers with culture media (Pollock, Goodwin and Greene 1954, Brumfield 1955). Recently Williams (1959) developed a technique to grow the seminal and nodal root systems separately in concentric polystyrene containers filled with vermiculite. The number of seminal roots produced per seed is apparently, a genetic function. A large seeded annual species develops a larger number of them than the small seeded perennial species (Pavlychenko 1942). *Elymus canadensis* develops four seminal roots while *Andropogon gerardii*, *Panicum virgetum* and *Bouteloua gracilis* develop only one each (Robocker, Curtis and Ahlgren 1953). Weaver and Zink (1945) found that seminal roots alone were able to support plants for a considerable time ; in some cases up to four months. These appear to function for 3 to 4 weeks in *Eragrostis curvula* (Crider 1945), in *Bouteloua gracilis* for 4 to 6 weeks (Riegel 1941), in *Andropogon furcatus* for 18 months (Stoddart 1935) and in *Dactylis glomerata* they die in the second summer. Stuckey (1941) gave the period as 6 to 8 weeks for ten species of temperate grasses, while the branched seminal root of *Lolium perenne* was stated to be still growing when ten weeks old but Yates and Jacques (1933) stated the longevity of seminal root in *Lolium perenne* as 3·5 months from the time of sowing and it had a measurable effect on tiller and leaf production for fully five months over and above that of the nodal roots. The imposition of a period without water if not too severe probably also tended to prolong the life of seminal roots (Olmsted 1941, 1942 ; Glendening 1941).

METHODS OF STUDY

Grass seeds were sown in 12 in. pots filled with mixture of garden soil and sand in the ratio of 2 : 1 to facilitate root growth. Seminal and nodal root growth is observed at regular intervals after 10, 20, 35, 50, and 70 days' growth. Root systems of grass seedlings were washed free of soil with a mild jet of water after

presoaking for four hours in the water so that no damage to root-lets is possible. The root systems were then floated in water and charted on graph sheet ; the figures were later inked and photographed. Diameter of roots is measured with oculometer.

Dichanthium annulatum Stapf.

A perennial deep rooted bunch grass growing on alluvial plains and deltaic areas and is reported as the dominant grass of two major grassland types from the second, third and fifth agricultural and animal husbandry zones of India as defined by Whyte (1957).

Seminal root growth :

Dichanthium annulatum Stapf. has high percentage of seed germination during the months of June and July at 0·5 cm. depth below the soil surface. A single seminal root of about 9 cm. length emerges on the 3rd day after the seedling emergence, which is 0·3 mm. thick with primary laterals of 0·5 cm. extent. Now the seedling unfolds the third leaf on its culm. A ten day seedling bears one or two nodal roots on the first coleoptilar node while the primary laterals extend up to 5 cm. being concentrated on the middle of the seminal root. Nodal root is thicker than the seminal root. At the fifth leaf stage of the seedling the seminal root grows 2 cm. more linearly with branches of the second order. Nodal roots show about 7 cm. linear growth being 0·35 mm. thick while the seminal root has 0·08 mm. diameter. With the unfolding of the 5th leaf, there is numerical increase in the number of nodal roots and shortening and thinning of the seminal root system. An examination of thirty days old seedling shows the presence of 5 to 6 nodal roots of 0·512 mm. diameter and their linear growth ranges from 20 to 28 cm. whereas the maximum linear extension reached by seminal root system is up to 15 cm. only having 0·09 mm. diameter. Thus there is gradual decrease of diameter and extent of seminal root system compensated by numerical increase of nodal roots. Longevity of seminal root system is observed up to 5 weeks from the time of sowing when the tillers appear on the seedling.

Bothriochloa intermedia A. Camus.

A tufted perennial grass, bears culms of 2 to 6 ft. height arising from a short hard rhizome. It is common in forest glades and in the open plains and grows also in damp places in clumps and also on rocks in streams, on heavy and poorly aerated soils (Bor 1941).

Seminal root growth :

Seeds of *Bothriochloa intermedia* whose viability is lost after one year of storage germinate at 1 cm. below the surface in pots. The seedling bears a single unbranched seminal root with minute protruberances at single leaf stage. It is 8 cm. in length and 0·28 mm. in diameter. When the second leaf unfolds, the primary laterals concentrate on the upper half of 10 cm. long seminal root. Further growth proceeds towards the extension of laterals up to 4 cm. at the third leaf stage of the seedling. It remains at 0·672 mm. diameter when a single nodal root is seen at the top of the mesocotyl. By the 5th leaf stage of the seedling one branched and an unbranched nodal root attains prominance while the seminal root system extends linearily up to 19 cm. being 0·24 mm. in diameter. At this stage the seminal root system has extensive absorptive area over the nodal root system. When the seedling attains 30 days' growth, five nodal roots with laterals of second order

develop, being thicker than the seminal root which is still extensive. Further growth trends in seminal and nodal root systems are followed up to the 7 weeks time from the date of seedling emergence. Finally the nodal roots increase in number up to 10 with their extensive branches while the seminal root is almost reduced both in extent and diameter.

Vetiveria zizanioides (Linn.) Nash.

This is a densely tufted tall perennial grass with branching root stock bearing aromatic roots. It is common on heavy soils in the open where it is often gregarious in thick tufts. The well-known 'Khus-khus' mats are made from its fragrant roots.

Seminal root growth :

Seeds of *Vetiveria zizanioides* are viable even after one year of storage from harvest. These germinate at 2 mm. soil depth. A single seminal root emerges out into the soil with one or two primary laterals at the top. It is about 7 cm. in length and 0·592 mm. in diameter when the second leaf unfolds. Seminal root growth is quick both linearly (0·5 cm.) as well as laterally at the fourth leaf stage of the seedling. A well branched nodal root is present at this stage. Two branched and one stout nodal roots figure prominently while the seminal root growth attains 14 cm. linearly along with primary laterals. Further observation shows that the rapid linear growth of the seminal root system proceeds up to 22 cm. when the two nodal roots on either side (being thick) branch up to the second order. Nodal roots are 7 cm. long and 0·32 mm. diameter, while the seminal root is 0·08 mm. in diameter associated with a high degree of branching. The seedling is 38 days old by this time. There is an extensive seminal root system as well as a stout lengthy nodal root system when the seedling is 50 days old. Weekly observations reveal that the extent of the seminal root system diminished after 10 weeks period from the date of the seedling emergence.

Chrysopogon montanus Trin.

Morphology and ecology :

Perennial tufted grass with slender culms, attains a height of 30 to 100 cm., Spikelets are in groups of three each, one sessile bisexual awned spikelet in the centre with two lateral unawned pedicelled spikelets.

This grass is found invariably on dry sandy and stony soils with little capacity for holding water. It is well distributed all over Utter Pradesh (Bor 1941). It is the best fodder grass if utilised before it flowers.

Seedling emergence :

Seeds are mostly viable and germinate even if partly embeded in the soil. Seedlings emerge within three days of sowing.

Seminal root :

A ten day old seedling has 3 leaves with a single seminal root of 7 cm. length usually of 0·25 mm. diameter. Small protuberances of primary laterals are seen at this stage. A single nodal root of 1·5 to 2 cm. extent with 0·20 mm. thickness develops from the coleoptilar node while the seminal root has attained a length

of 12·5 cm. Primary laterals are slow in linear growth at the 5th leaf stage of the seedling. Next stage of seedling growth shows two prominent 0·32 mm. thick nodal root on either side of the seminal root. Nodal roots are 8 cm. and 12 cm. in length with well developed laterals.

The seminal root grows quickly with poor branching and overtakes the nodal roots in linear growth (17 cm.). Diameter of the seminal root is very much reduced (to 0·08 mm.). When the seedling has developed the ninth leaf, the seminal root throws out laterals of moderate extension. Now the nodal roots are 12 cm. and 9 cm. in length, with 0·48 mm. diameter. Further weekly observations show marked extension of nodal roots over seminal root system which gradually dwindles away. Seminal root system persisted up to 8 weeks from the date of seedling emergence when initiation of tillers took place.

Heteropogon contortus (Linn.) Beauv. ex R. and S.

Morphology and ecology :

A tall perennial tufted grass, either grows erect or decumbent, being mostly leafy at the base. Leaves are 60 cm., long and 3 to 7 mm. wide, firm and linear. Spikelets are grouped into terminal racemes and these are prominent with their dark brown awns jointly twisted to form a bundle.

This grass prefers drier areas as well as poor rocky soils where it becomes dominant. It is well distributed in Utter Pradesh (Bor 1941).

Germination :

Seeds are brownish black in colour and are elliptical in shape. These germinate at 1 cm. depth or even at soil surface.

Seminal root :

A single seminal root of 10 cm. length with well developed primary laterals grows from a 10 day old seedling. The seminal root has 0·13 mm. diameter with uniformly distributed laterals. At the fifth leaf stage of the seedling, nodal root of 11 cm. extent figures by the side of the seminal root. The seminal root is 0·086 mm. thick when the nodal root is of 0·23 mm. thickness. Both seminal and nodal roots have equal linear growth. Root hair like structures develop on the mesocotyl region, which perhaps supplement the absorption area. After an interval of 15 days, the seminal root attains its maximum linear growth of 14 cm. with closely placed laterals. Comparatively thicker nodal roots with even distribution of laterals lie on either side of the seminal root. Nodal root length is usually 9 to 10 cm. one of which develops 7 cm. long primary lateral with secondary root branches. The seminal root system is extensively branched with 5 to 6 cm. long primary laterals. At this stage the seedling has unfolded the 8th leaf. Further observations showed decline of seminal root extension. Seedlings with well developed tillers showed the presence of truncated seminal root system. Longevity of the seminal root is up to 10 weeks from the time of the seedling emergence.

CONCLUSION

The behaviour of seminal roots of five perennial grasses is reported in this paper. The study reveals that these grasses develop a single seminal root on germination of seeds. The nodal roots initiate at the 4th leaf stage of the seedling in *Dichanthium* and *Vetiveria* but they develop earlier as the second leaf unfolds in

Bothriochloa. The maximum linear growth of the seminal root system is 19 cm. in *Bothriochloa intermedia*, 22 cm. in *Veitveria zizanioides* and 11 cm. in *Dichanthium annulatum* at the fifth leaf stage of their seedlings while the seminal root longevity is 7 and 10 weeks in the former two and 5 weeks in the latter. The longevity seminal roots in *Heteropogon contortus* is 10 weeks, and while that of *Chrysopogon montanus* is eight weeks only. These last two grasses grow on xeric and stony soils.

ACKNOWLEDGMENT

I am thankful to Prof. R. Misra, M.Sc., Ph.D., F.N.I., F.N.A.Sc., Head of Botany Department, Banaras Hindu University, for encouragement and guidance.

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STUDIES ON GALL MIDGES (ITONIDIDAE : CECIDOMYIIDE : DIPTERA—NEMATOCERA) FROM INDIA

By

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[Received on 14th August, 1961]

Description of one new species of Indian gall midge, namely *Meinertomyia ovalis* from Allahabad and new locality records of two known species, form the subject matter of this paper.

Subfamily **Itonididinae**

Tribe *Trifilini*

Pipaldiplosis pipaldiplosis Mani

1934. *Pipaldiplosis pipaldiplosis*, Mani, *Indian J. Ent.*, 4 (1) : 40.

1949. *Pipaldiplosis pipaldiplosis*, Rao, *Indian J. Ent.*, **11** (2) : 126.

This species was first described by Mani and only male specimen reared from gall No. 267 on the leaf veins of *Ficus religiosa* Linn., at Delhi. Rao (1949) described the female. I have collected one male specimen which agrees with the original description of this species.

This midge, which was previously reported from a large number of places in India, is for the first time being reported from Allahabad (U. P.).

Tribe *Dasyneurini*

Dasyneura lini Barnes

1936. *Dasyneura lini*, Barnes, *Ann. Mag. Nat. Hist.*, **17** (**10**) : 273–74.

I have before me several males and females, reared from the infected buds of linseed and labelled "Reared in the laboratory from the infected buds of *Linum usitissimum* Linn., Feb. 1961, Allahabad, Coll. P. Grover."

This midge was previously recorded from Pusa (Bihar), Delhi and Nagpur. This is being reported to be a minor pest in Allahabad also.

This is parasatized by an unknown Chalcid.

Subfamily **Heteropezinae**

Meinertomyia ovalis, sp. nov.

Female.—2·8 mm. Body light brown. **Head** : *Eyes* confluent above. *Palpi* (Fig. 16) triarticulate, pale-yellow, sparsely setose ; first segment rectangular, with one side slightly bulging ; second segment twice the length of the first and longest of all, cylindrical, length one and one-half times its own diameter ; third segment slightly shorter than the second, cylindrical, broad apically, length a little more than thrice the maximum thickness. *Antenna* light brown, with 14 segmants, shorter than body, segments gradually becoming narrower and shorter distally, each with two whorls of stout and long setae ; first segment (Fig. 1) pale-yellow, stout apically, nearly cup-shaped, as long as thick at apex ; second

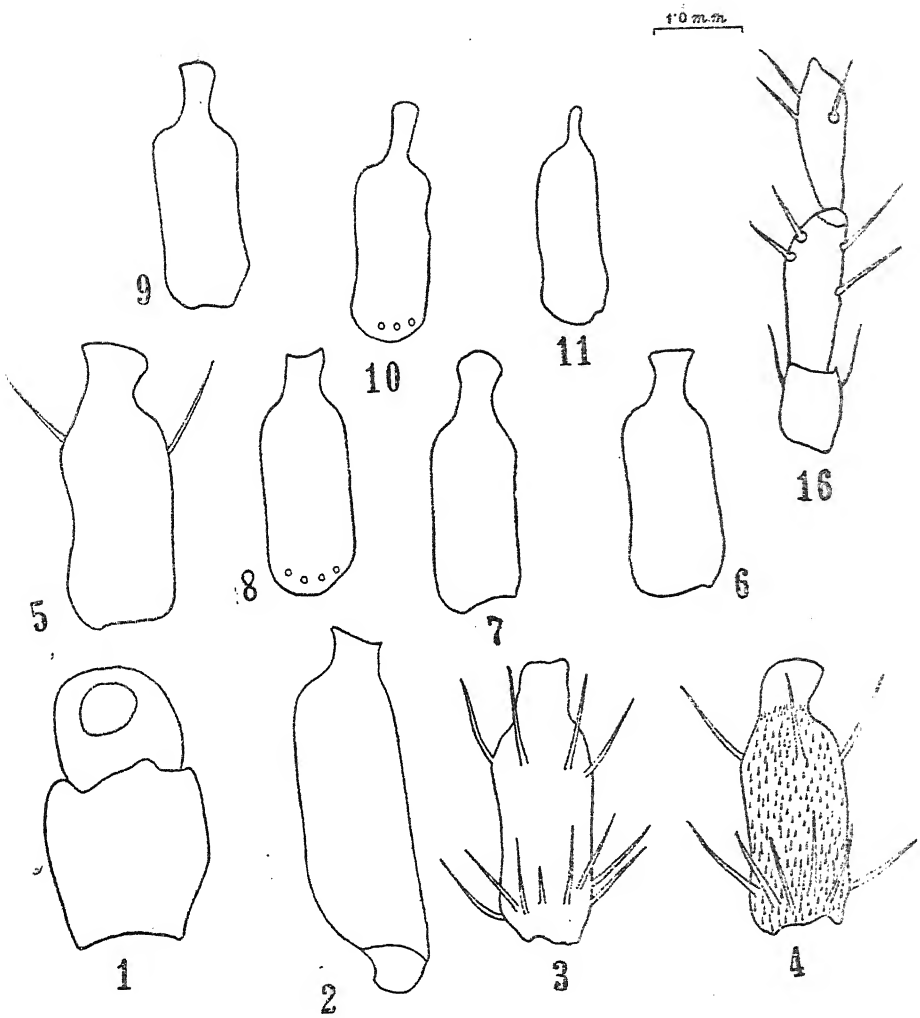
segment (Fig. 1) as long as first, globose ; third segment (Fig. 2) not fused with the fourth but longer than the latter, with very short basal stem, a little more than one-fifth of enlargement and as long as broad ; enlargement nearly four-fifths the length of segment and nearly two and a-half times the maximum thickness, apical stem short, a little over one-seventh the length of enlargement, as thick as basal stem ; fourth segment (Fig. 3) shorter than the third, enlargement five-sixths of the length of segment, length nearly two and one-thirds of its own thickness, stem one-fifth the length of segment and a little less than its own thickness ; fifth segment (Fig. 4) shorter than the fourth, enlargement nearly six-sevenths of the length of segment and nearly twice as long as thick, stem nearly one-fifth of the length of enlargement and a little wider than long ; sixth segment (Fig. 5) shorter than the fifth, enlargement nearly three-fourths the length of segment and less than twice its maximum thickness, stem a little more than one-third the length of enlargement and as long as broad ; eighth segment slightly shorther than the sixth, stem a little shorter than that of sixth segment ; ninth segment (Fig. 6) equal to the sixth segment ; tenth segment (Fig. 7) equal to the ninth except the stem, slightly longer than thick, enlargement slightly longer and narrower than that of ninth segment ; eleventh segment (Fig. 8) sligtly shorter than the tenth segment but similar in all respects except the enlargement, which is a little shorter ; twelfth segment (Fig. 9) as long as eighth segment, enlargement five-sixths the length of segment and nearly two and one-fourth times as long as thick, stem nearly one-fourth the length of enlargement and one and one-half times as long as broad ; penultimate segment (Fig. 10) as long as eleventh segment, enlargement three-fourths the length of segment and nearly two and one-fifth times as long as board, stem one-sixth the length of enlargement and twice as long as broad ; terminal segment (Fig. 11) shorter than all, with apical prolongation, enlargement four-fifths the length of segment and two and two-fifth times as long as broad, the apical prolongation one-fourth the length of enlargement and three times as long as thick. **Thorax** : *Mesonotum* light yellowish-brown, scutellum a little darker than the latter. *Halteres* (Fig. 12) pale-yellow. *Wing* (Fig. 14) hyaline, less than thrice the maximum breadth, vein R_s wanting, vein R_5 reaching the wing margin well beyond the apex, costa interrupted at its union with R_5, vein *Cu* simple and not very distinct. *Legs* long, densely hairy, with five tarsal segments, metatarsus shorter than the second tarsal segment. *Claw* (Fig. 13) simple, strongly bent, empodium longer than the claw. **Abdomen** : *Ovipositor* (Fig. 15) light brown, sparsely setose, exserted, with one dorsal broadly oval and two elongated oval ventral lamellae.

Holotype.—One female dissected and mounted on three slides, and labelled. "At light, Tagore twon, Allahabad. Coll. P. Grover, 8. vii. 1960." The slides are retained in the collection of the author for the time being.

This species is separated from *M. manii* Rao by the shape and the differences in the proportion of palpal segments, vein *Cu* simple and faint, scutellum darker than the mesonotum, empodium longer than the claw, ovipositor with one dorsal broadly oval and two elongated oval ventral lamellae.

KEY TO SPECIES

1.	The three palpal segments of equal length or nearly so ; terminal flagellate segment trinodose, moniliform ; empodium about three-fourths the length of claw ..	*M. aequipalpis* Mani.
	The three palpal segments of unequal length ..	2.
2.	First palpal segment longest of all, flagellate segments shorter and pyriform ; empodium	

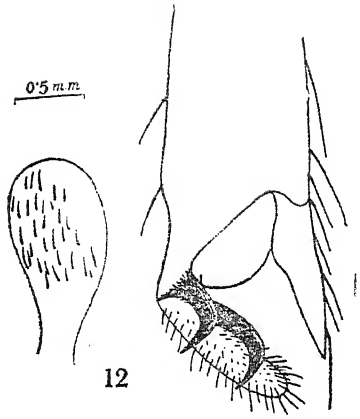


half the length of claw; ovipositor with linear-elliptic lamellae .. *M. inaequipalpis* Mani

Second palpal segment longest of all; third and fourth antennal segments fused together or not; *Cu* vein simple or forked .. 3.

3. Third and fourth antennal segments fused together and equal, antenna longer than body; vein *Cu* forked; ovipositor with elongated lamellae .. *M. manii* Rao

Third and fourth antennal segments not fused together and also unequal, antenna shorter than body; *Cu* vein simple and faint; ovipositor with one dorsal broadly oval and two elongated oval ventral lamellae .. *M. ovalis* Grover, sp.no.v



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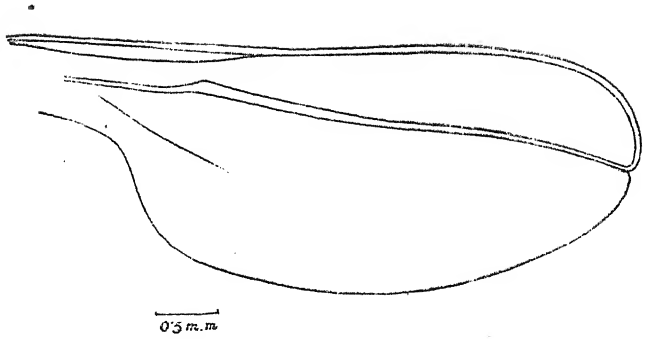

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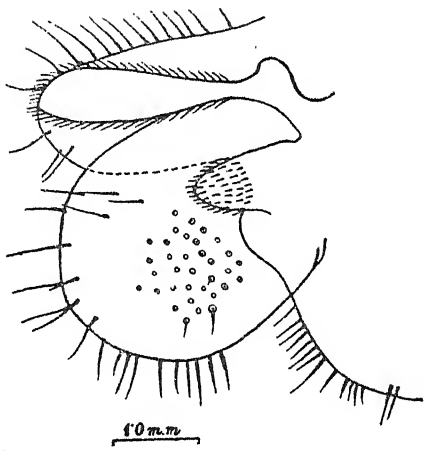

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11. Terminal segment.
12. Haltere.
13. Claw.
14. Wing.
15. Ovipositor.
16. Palpus.

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FUNGUS FLORA OF STORED VEGETABLE AND PULSE SEEDS, ITS RELATION TO PRE-EMERGENCE INJURIES AND THE BENEFICIAL EFFECTS OF FUNGICIDAL SEED TREATMENTS*

PRAKOB KANJANASOON *and* R. S. MATHUR

[Received on 8th November, 1960]

INTRODUCTION

Since 1950 studies on the fungus flora of stored seeds, its relation to pre-emergence injuries and the beneficial effects of seed treatment with fungicides are in progress at the Mycology Section of the Indian Agricultural Research Institute, New Delhi [(Gopal Swarup (1950), Murthy (1951), Sreekantiah (1952)]. The present paper includes the results of similar studies carried out with vegetable and pulse seed.

MATERIAL AND METHODS

Stored seeds of the following 7 vegetables and 3 pulses were obtained from Mohan Stores, Ajmal Khan Road and several seed merchants of Sabzimandi, Delhi.

Vegetable : Onion (*Allium cepa* L.) ; Chilli (*Capsicum frutescens* L.) ; Cucumber (*Cucumis sativus* L.) ; Tomato (*Lycopersicon esculentum* Mill) ; Cabbage (*Brassica oleracea* L. var. *Capitata* L.) and Cauliflower (*Brassica oleracea* L. var. *botrytis* L.).

Pulses : Mung (*Phaseolus aureus* Roxb.) ; Urid (*Phaseolus mungo* L.) and Bean (*Phaseolus vulgaris* L.).

The methods reported by Sreekantiah and Mathur (1961) were followed in all experiments included in this investigation.

EXPERIMENTAL

The following organisms were isolated :

(*a*) *Fungus flora associated with the seed.*

(*i*) **Vegetable.**

ONION : *Fusarium* sp., *Aspergillus niger*, *Rhizopus* sp. *Alternaria palandui.*

CHILLI : *Fusarium* sp., *Cercospora capsici*, *Rhizopus* sp. *Penicillium digitatum*, *Alternaria* sp.

CUCUMBER : *Fusarium* sp., *Aspergillus niger Alternaria* sp.

TOMATO : *Alternaria solani* and spores of moulds.

BRINJAL : *Fusarium lycopersici.*

*Condensed from a portion of a thesis by the senior author, submitted to the Research Council of the Indian Agricultural Research Institute, New Delhi, in partial fulfilment of the requirements for the diploma Assoc. I. A. R. I.

CABBAGE : *Acrothecium* sp., *Alternaria brassicae*.

CAULIFLOWER : *Helminthosporium* sp. and spores of moulds.

(*ii*) **Pulses.** MUNG : *Cercospora cruenta*, *Alternaria tenuis*.

URID : *Fusarium* sp., *Alternaria tenuis*, *Aspergillus niger*.

BEAN : *Fusarium* sp., *Alternaria* sp.

Alternaria palandui, *A. tenuis* and *Fusarium* sp. were most commonly associated with vegetable and pulse seeds. *Alternaria palandui* and *A. tenuis* were selected as test organisms for causing seed rot and pre-emergence injuries in onion and mung seed respectively. Onion seeds were selected from among the 7 vegetable seeds and mung from among the 3 pulses.

(*b*) *Role of pre-dominant fungi in relation to the germination and vigour of onion and mung seed* :

The inoculum of *Alternaria palandui* and *A. tenuis* was multiplied on 5 percent maize meal medium in Erlenmeyer flasks and 250 gm. of this inoculum was added to six inch pots in an experiment having the following treatments :—

(*a*) Untreated seed in sterilised soil.

(*b*) Surface sterilised seed in soil inoculated with *Alternaria palandui* or *A. tenuis*.

(*c*) Surface sterilised seed in ordinary soil.

One hundred seeds of onion and 50 of mung were sown per pot and three pots were used for each treatment. In order to study the relation of *Alternaria palandui* on onion seed and *A. tenuis* on mung seed with the emergence and vigour of seedlings emergence counts were taken on the twelfth day. The experiment was conducted with in a temperature range of 50–96°F. Relevant data are given in Table 1.

TABLE 1

Role of *Alternaira palandui* and *A. tenuis* on the emergence and vigour of seedlings

Treatments		Percent emergence	Weight of 20 seedlings in gm.	Height of 20 seedlings in cm.
Untreated seed in sterilised soil.	ONION	38·3	0·7	4·5
	MUNG	61·6	2·3	5·0
Surface sterilised seed in soil infested with *Alternaria* sp.	ONION	22·0	0·57	3·4
	MUNG	61·0	2·2	4·7
Surface sterilised seed in ordinary soil	ONION	53·0	0·8	5·3
	MUNG	84·0	3·0	5·7

When surface sterilised seeds of onion and *mung* were sown in autoclaved soil, there was significant improvement in emergence, weight and height of seedlings. There was 31 and 23 percent reduction respectively in the emergence of

onion and *mung* seeds when sown in soil infested with *Alternaria palandui* and *A. tenuis* respectively.

(*c*) *Beneficial effects of fungicidal seed dressings.*

The relative efficacy of different fungicides in destroying the fungus flora associated with stored seeds of onion and *mung* was tested by treating the seed with fungicides in specified doses and plating them in 2 percent potato dextrose agar (pH 4·5) in Petri dishes. For each treatment 3 plates were used and 8 seeds were plated in each Petri dish. The plates were incubated at room temperature (20–30°C) and the percentage of colonies was recorded after 10 days as given in table 2.

TABLE 2

Effect of different fungicides on the fungal flora of stored onion and mung seed

Treatments	Percentage of fungal colonies											
	Fusarium sp.		Alternaria palandui or A. tenuis		Aspergillus-niger		Penicillium digitali		Rhizopus sp.		Miscella-neous	
	Onion	Mung	Onion	Mung	Onion	Mung	Onion	Mung	Onion	Mung	Onion	Mung
Arasan (1 : 1000) (Tetramethyl thiurum disulphide)	4	...	...	...	36	2	10	...	6	...	...	2
Ceresan (2 : 1000) (Ethyl-mercuric chloride)	...	...	...	...	2	...	...	...	6	...	...	...
Semesan (3 : 1000) (Hydroxymercuri—chlorophenol)	2	2	...	...	...	...	...	...	...	...	...	2
Semenon (3 : 1000) (A Finish-compound)	2	...	...	...	34	...	8	...	2	2	...	...
Copper carbonate (3 : 1000)	2	4	...	...	52	20	12	10	8	8	14	8
Spergon (2 : 1000) (Tetrachlora p-benzo-quinone)	...	...	...	..	12	...	2	...	4	...	2	...
SR-406 (1 : 1000) N-trichloromethylthio-tetrahydrophthali-mide	...	...	...	...	6	...	...	...	32	...	...	...
Formaldehyde solution (1 : 1000)	...	...	...	...	2	...	...	...	...	...	2	4
Mercuric chloride solution (1 : 1000)	...	...	...	...	...	...	...	...	...	...	...	...
Control	2	...	2	2	50	34	4	4	32	44	8	6

It may be noticed from table 2 that the onion seeds treated with mercuric chloride, showed complete freedom from any fungus growth. Only 2 percent *Aspergillus* and 6 percent *Rhizopus* colonies were isolated from seeds treated with Ceresan ; *Aspergillus* and miscellaneous fungi and bacteria were also isolated from Semesan and formaldehyde treated seeds. Copper carbonate was not effective in checking the growth of fungi. In the case of *mung* no fungus colonies developed

from seeds treated with Ceresan, Spergon, SR—406 and mercuric chloride. Semesan and formaldehyde were less effective and Copper carbonate was the least effective in inhibiting the growth of fungus colonies. Untreated seeds of onion and *mung* naturally gave the maximum number of fungus and bacterial colonies. The germination of all fungicide treated seed was better than the control.

(*d*) *Beneficial effects of fungicides in green house tests.*

Studies on the effect of different fungicides on the fungus flora of seeds under laboratory conditions indicated that fungicides differ from each other in their effectiveness to inhibit the growth of fungi. Pot experiments were, therefore, conducted to determine the relative efficacy of different fungicides on the germination of onion and *mung* seeds and the stand and vigour of seedlings. The seeds treated with 9 fungicides in doses specified in the last experiment were sown in ordinary field soil in 10" pots. Four pots were used for each treatment and in each pot 100 seeds were sown. While the experiments were in progress the temperature ranged from 50–83°F for onion and 50–96°F for *mung*. Emergence counts were taken daily and the final reading was taken after 30 days, after which the average weight (in gms.) and height (in cms.) of 20 seedlings selected at random were taken. Consolidated results are given in table 3.

TABLE 3

Relative efficacy of different fungicides on the emergence stand and vigour of onion and mung seedlings

Treatments	Onion			Mung		
	Percent Emergence	Seedlings Weight gm.	Seedlings Height cm.	Percent Emergence	Seedlings Weight gm.	Seedlings Height cm.
Arasan	63·0	0·97	5·3	93·7	6·0	6·5
Ceresan	67·5	1·15	5·8	97·5	6·5	6·7
Semesan	60·0	1·10	6·8	95·0	5·4	5·9
Semenon	66·2	1·17	5·7	92·5	6·4	6·8
Copper carbonate	57·5	1·01	6·1	96·5	6·3	5·8
Spergon	60·0	1·12	6·2	91·2	6·1	6·1
Formaldehyde	48·7	1·01	5·5	86·2	5·9	5·4
Mercuric chloride	60·2	1·15	6·3	93·7	5·9	5·8
SR–406	62·5	1·25	6·3	90·0	6·4	6·8
Control	52·5	0·75	4·7	87·5	4·9	5·7

Cereson improved the emergence of onion *mung* seed by 16 and 10 percent respectively. Treatment of onion seed with Semenon increased the weight of seedlings and with Spergon treatment the height increased. Next to Ceresan, SR–406 was responsible for increase in weight and height of *mung* seedlings.

(e) *Relative emergence and seedling height of Ceresan treated and untreated onion and mung seeds sown in sterilised soil and in soil infested with Alternaria* sp.

This study was undertaken with 6" pots and Ceresan treated and untreated onion and *mung* seeds were sown in soil infested with *Alternaria* sp. and sterilised soils as follows :

A. Untreated seeds in sterilised soil.

B. Untreated seeds in infested soil.

C. Ceresan treated seeds in *Alternaria palandui* or *A. tenuis* was used. Fifty seeds were sown per pot. Each treatment was replicated six times and the experiment was repeated twice and carried out at a temperature range of 50–90°F. Relevent data are presented in table 4.

TABLE 4

Relative emergence and seedling height of Ceresan treated and untreated onion and mung seed

	A		B		C	
	Present emergence	Height of seedlings cm.	Percent emergence	Height of seedlings cm.	Percent emergence	Height of seedlings cm.
Onion	44	3·4	36	4·0	51	4·9
Mung	90	4·8	86·5	5·0	94	6·7

It will appear from these data that emergence and height of seedlings were markedly reduced when onion and *mung* seeds were sown in *Alternaria* infested soil without treatment with a fungicide. However, when Ceresan treated seeds were sown in sterilised soil, there was 15 percent increase in the emergence of onion seed and 7·5 percent increase in the emergence of *mung* seeds. The height of seedlings increased slightly over treatment *A* (probably because maize meal provided nourishment to the growing seedlings). Treatment *C* stimulated the best height of seedlings for which treatment of seeds with Ceresan may be responsible.

DISCUSSION

Most fungi carried through the seeds used in this investigation were saprophytic. Detailed experiments on onion and *mung* showed that *Alternaria tenuis* was predominantly associated with the seed and caused appreciable reduction in emergence. Onion seed showed poor viability which increased from 44 to 51 percent by treating the seed with Ceresan. However, emergence and height of seedlings improved when Ceresan treated onion and *mung* seeds were sown in autoclaved soil. No work of this type on *mung* has been reported in literature but on onion and other vegetable and pulse crops, Walker (1948) has ably reviewed the relevent literature. Clayton (1928) showed marked improvement in stand with a number of vegetables when seeds were treated with organic mercury compounds, Semesan, Uspulun and Bayer Dipdust applied in liquid or dust form. Selby (1900) reported that the onion smut can be prevented by treating the seeds with formalin at the rate of one pound to 50 gallons of water. But since this disease has not been reported to occur in India, we are not confronted with this problem. Studies on vegetable seed (including lima beans) treatments in U. S. A.

have been ably compiled recently by McNew (1944). The general conclusion from our experiments indicates that treatment of vegetable and pulse seed particularly with Ceresan, Semenon Semeson and SR–406 is conducive to better sprouting, weight and height of seedlings.

SUMMARY

A number of fungi were found to be associated with samples of 7 vegetable and 3 pulse seeds. Onion and *mung* seeds which were taken up for pot culture work also. *Alternaria palandui* and *A. tenuis* respectively predominated and when such seeds were sown in autoclaved soil or in soil infested with additional inoculum of this fungus the emergence, height and weight of seedlings were reduced. Ceresan treatment not only helped to overcome the deleterious effects of the associated fungi but also improved the emergence and height of seedlings appreciably.

ACKNOWLEDGMENTS

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NOTE ON THE LIFE-HISTORY OF MUSTARD APHID, *LIPAPHIS ERYSIMI* (KALT)

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INTRODUTION

Mustard is widely cultivated in India from time immemorial for its seed, which contains a large quantity of oil, which is extracted and sold under the name mustard oil. Thus mustard plays an important role in the agricultural economy of Uttar Pradesh. *Lipaphis erysimi* (Kalt) is one of the most destructive insect pests of mustard crop throughout the country.

Distribution :

The pest is widely distributed throughout the whole of Uttar Pradesh and is a serious pest of mustard, cabbage, cauliflower and radish in Varanasi, Jaunpur, Azamgarh, Faizabad, Lucknow, Kanpur, Kannauj, Farrukhabad, Agra, Meerut and Aligarh districts.

Different species of aphids present on different vegetable host plants were collected from the various districts after an extensive survey and are given below :—

Districts	*Spp. of Aphids collected*
1. Azamgarh	1. *Aphis craccivora* Koch.
	2. *Lipaphis erysimi* (Kalt.)
	3. *Longiunguis sacchari* (Zehnt.)
	4. *Aphis malvae* Koch.
2. Janupur	1. *Aphis craccivora* Koch.
	2. *Aphis malvae* Koch.
3. Lucknow	1. *Lipaphis erysimi* (Kalt.)
	2. *Aphis craccivora* Koch.
4. Agra	1. *Lipaphis erysimi* (Kalt.)
	2. *Aphis malvae* Koch.
5. Meerut	1. *Lipaphis erysimi* (Kalt.)
	2. *Aphis craccivora* Koch.

Districts	Spp. of Aphids collected
6. Kanpur	1. *Lipaphis erysimi* (Kalt.) 2. *Aphis gossypii* Glov. 3. *Longiunguis sacchari* (Zehnt.) 4. *Aphis craccivora* Koch.
7. Aligarh	1. *Lipaphis erysimi* (Kalt.)
8. Kannauj	1. *Aphis craccivora* Koch. 2. *Aphis malvae* Koch.
9. Farrukhabad	1. *Aphis craccivora* Koch. 2. *Aphis malvae* Koch.
10. Faizabad	1. *Lipaphis erysimi* (Kalt.) 2. *Aphis malave* Koch. 3. *Aphis craccivora* Koch.
11. Varanasi	1. *Lipaphis erysimi* Kalt. 2. *Aphis craccivora* Koch. 3. *Aphis gossypii* Glov.

Life History :

The population of mustard aphis is widely affected by the climatic factors prevailing in the environment. Damp weather and moist winds are most suitable for the multiplication of mustard aphis. It was observed that if such weather prevalis for 2–3 days continuously, most of the mustard plants were severely damaged and cultivators face great problem with this pest.

Adults :

The wingless adult female is very minute in size. They are of yellowish green colour with sucking mouth parts. A pair of cornicles are present on the 5th abdominal segment. The winged form has got transparent wings and abdomen yellowish in colour in earlier stages. They are about 1/10th of an inch in length. Some adults are wingless and some have hyaline wings.

Parthenogenesis :

Mustard aphids, appearing in the month of November-December on mustard crop in small number, are mainly wingless viviparous female. Viviparity and parthenogenesis are both common phenomenon among aphids. Viviparity is accompanied by parthenogenesis. These females give rise to the living young ones which are called nymphs. These nymps on maturation again produce young ones in usual manner as stated above.

Duration of Nymphal Stages :

The young ones become mature within a few days and give rise to new generation in same manner and thus the colony increases. Following table indicates the duration of nymphal stages. There are four nymphal instars of this pest. The

details of duration of nymphal stages and number of instars are shown in the following table :—

Table showing the Duration of Nymphal Stages

Date of hatching	Date of first moult	Length of first Instar (days)	Date of second moult	Length of second Instar (days)	Date of third moult	Length of third Instar (days)	Date when adult form assumed	Length of fourth Instar (days)	Total nymphal period
15–12–60	17–12–60	2	19–12–60	2	22–12–60	3	25–12–60	3	10
17–12–60	19–12–60	2	21–12–60	2	24–12–60	3	27–12–60	3	10
23–12–60	25–12–60	2	28–12–60	3	31–12–60	3	3–1–61	3	11
2–1–61	5–1–61	3	7–1–61	2	10–1–61	3	14–1–61	4	12
6–1–61	8–1–61	2	10–1–61	2	13–1–61	3	17–1–61	4	11
12–1–61	15–1–61	3	18–1–61	3	21–1–61	3	24–1–61	3	12
19–1–61	21–1–61	2	24–1–61	3	28–1–61	4	31–1–61	3	12
27–1–61	29–1–61	2	1–2–61	3	5–2–61	4	9–2–61	4	13
3–2–61	6–2–61	3	9–2–61	3	12–2–61	3	16–2–61	4	13
11–2–61	14–2–61	3	18–2–61	4	22–2–61	4	25–2–61	3	14
14–2–61	18–2–61	4	21–2–61	3	24–2–61	3	28–2–61	4	14

From the above table it is clear that nymphal period varies from 10–14 days and there are four nymphal instars.

Rate of Reproduction :

It has been observed in the laboratory that rate of reproduction varies from 3–9 young one's in a single day by a single female.

Fecundity :

Total number of young one's laid by a single female in her lifetime varies considerably from female to female. It varies 76 to 188 young one's in whole of life of the female.

Generations :

Five overlapping generations have been observed in the laboratory during the season.

SANN HEMP STEM-BORER AND ITS CONTROL

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INTRODUCTION

Damage :

Sann hemp stem-borer, *Enarmonia pseudonectis* Meyr. is usually a minor pest of *sanai* crop but under favourable conditions, sometimes it causes great loss especially to the fibre as its length is much reduced on account of gall formation. Injury to the crop is caused by the caterpillars which bore into the stems near the nodes and thereby cause small gall-like swellings on the infested shoots. It has also been observed that when the crop reaches its maturity, the caterpillars are also found to bore the capsules and eat away the seeds.

Life History :

The adult is a small dusky, grey or greyish brown moth which is some times found flying in abundance in shady places. The eggs are laid near the axils of the leaves and hatch in about 4–7 days. Young caterpillars at first nibble on the epidermis of the leaves, but later on bore into the shoot. The caterpillar is smooth and measures about quarter of an inch in length. The colour of the caterpillar is at first pale white with dark brown head and prothoracic shield but later on changes to pinkish-red. Pupation takes place in fine silken cocoons inside the galls. Pupal-period lasts for 3–7 days and the moths emerge out through a previovsly designed exit. Several broods continue their attack on *sanai* crop throughout the kharif season.

Control :

With a view to evolve suitable method of its control an insecticidal trial was conducted at the Regional Research Station, Amrokh (Moth), Jhansi during Kharif 1960. The following treatments were applied :—

1. Spraying the crop with 0·03% diazinon @ 60 gallons per acre.
2. Dusting the crop with 10% DDT dust @ 20 lbs. per acre.
3. Spraying the crop with 0·25% BHC suspension @ 60 gallons per acre.
4. Spraying the crop with 0·25% DDT suspension @ 60 gallons per acre.
5. Dusting the crop with 10% BHC dust @ 20 lbs. per acre.
6. Dusting the crop with 5% BHC dust @ 20 lbs. per acre.
7. Control (untreated).

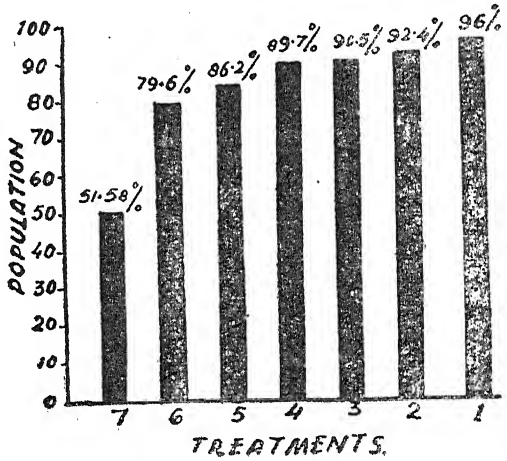
Observations were recorded before the application of treatments and three weeks after by counting the number of living caterpillars in 25 galls collected from different places of the experimental plots.

The effectiveness of various insecticides is represented in the following histogram. The highest reduction in the population of the gall-makers was achieved from the plots treated with 0·03% diazinon @ 60 gallons per acre, which was 96·00%.

STATISTICAL ANALYSIS

The results of this trial were also statistically analysed and the variations due to treatments were found to be highly significant at 0·1% level of probability. The best treatment was spraying the crop with 0·03% diazinon followed by dusting the crop with 10% DDT dust @ 20 lbs. per acre.

PERCENTAGE REDUCTION IN THE POPULATION OF *SANAI* SHOOT GALL MAKER, *ENARMONIA PSEUDONECTIS* MEYR.



ECOLOGICAL STUDIES OF WEEDS OF THE JASWANT COLLEGE COMPOUND, JODHPUR

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ABSTRACT

Plant life in the Indian Desert presents several problems. Its ecological study is of considerable interest. The study of weeds in India has been few and far between. The present investigation is an addition to the ecological study of the weeds. It was carried out in the year 1954–55.

The various ecological factors affecting the weed growth have been discussed thoroughly. In determining the vegetation, the quadart method was adopted as a result of which frequency of species growing in the campus at different places was found out. Physical and chemical analysis of the soil was carried out as a result of which it was found that the limiting factors in the development of vegetation are water content, humus content and percentage of water soluble salts.

Vegetation from the seasonal point of view had been studied and a list of weeds found in the area given. The commonest weeds are *Gynandropsis pentaphylla* Dc., *Trianthema monogyna* L., *Amaranthus viridis* L., *Tribulus terrestris* L., *Calotropis procera*, R. Br., *Tephrosia purpurea* Pers, *Prosopis julifera* Dc., *Aerua tomentosa* Forsk, *Boerhaavia diffusa* L. etc. The root system of weeds was of considerable interest. Anatomical studies of the different vegetative organs have shown that most of the weeds in the area possess xerophytic features. A few weeds have been suggested whose spread may be encouraged as an aid in the afforestation of the desert area.

INTRODUCTION

Plant life in the Indian Desert presents several problems and the ecological studies of the desert regions is of considerable interest. In order to understand this fully a study of the vegetation from different viewpoints such as ecology, geographical range of different species, their physiological behaviour, anatomical and several other aspects have to be made. The present study is an off shoot of this ecological work. It was carried out in the year 1954–55.

The study of weeds in India has been few and far between. The ecological studies on weeds have been only cursory and a number of workers like Biswas (1934), Sabnis and Singh (1934), Singh (1942), Misra (1946), Kumar, Solomon and Rao (1948), Pannikar (1950), Datta and Bannerjee (1954), Vaheedudin and Varai (1954) have either listed weeds or suggested methods of their eradication. Siddiqui and Syeeduddin (1954) studied the root habits of the weeds of the Osmania University Campus, Hyderabad, Deccan. So far as the author is aware no work has been published on weeds of the arid region.

The present investigation is an addition to the ecological study of the weeds. This study is likely to lead to selection of species helpful for covering and binding the loose soil. It might serve the useful purpose not only from the purely scientific and ecological point of view but also utilitarian purposes.

Situation and Topography :

Jodhpur is situated between latitude 27° and 27·5° longitude 72·5° and 73·5° in the North-west of Rajasthan. The topography of the area is considerably varied. Mostly there are plains in the area but towards the North-east regions

there are several discontinuous hill chains. The formation of depressions is very characteristic feature of the area. They are of the various dimensions and form a good basis for the vegetation to grow during the rainy season, since most of the rain water drains into these depressions. The advantage of the depressions has been taken in the construction of Jodhpur city. There are no natural tanks in the city. In the neighbourhood of Jodhpur there are several water reservoirs between the hills where the rain water collects and these form the main source of the supply.

The campus of Jaswant College where most of the study was conducted is nearly a rectangular area situated in a light depression outside the city, having a boundary wall. Within the area itself, there is a gradual slope toward the east and south at some places and the compound has roads dividing the area into small blocks. The rain water does not easily flow away but is retained in the sides of the different blocks.

Climatic Factors :

The rain fall of the area is scanty and very unrealiable, annual fall being from 14″ to 17″ only. It is the monsoon period *viz.*, June to September in which most of the rain fall occurs. But in this period also the rainfall may or may not be well distributed. Moreover the interval between the two successive rainy days is not definite.

There are extremes of hot and cold temperatures. The maximum temperature is in the month of May and the lowest temperature has been recorded in the month of January. In the month of May the increase of temperature to high degrees disturbs the water balance of the plants and the season presents a very poor aspect as far as the flora is concerned.

The relative humidity of the air is higher from July to September being maximum in August and mininmum in April. The annual mean humidity varies from 45 to 60%. The increase or decrease in the relative humidity correspondingly affects the decrease or increase of transpiration which in turn has a direct influence on the water balance of the plants.

A constant breeze from south-west to north-east blows from February to October with a velocity of 8 to 10 miles per hour. These winds have a dessicating effect specially in summer. That is why only extreme xerophytes are able to survive during this season. With the approach of rainy season the winds get charged with moisture and thus having less dessicating action on the vegetation.

Edaphic Factors :

The edaphic factors play a very prominent role in the development of the vegetation. In the present investigation an analysis of soil of different quadrats was carried out in the rainy and winter seasons as a result of which it was found that :

1. The soil is sandy and loose with very little humus content.
2. The soil is fairly rich in carbonates and chlorides.
3. The water content increases from the surface to the deeper layers.
4. The nitrates are usually deficient in soil.
5. The pH value ranges from 7·0 to 8·5 thus showing an alkaline nature which usually is more at the deeper layers of the soil.
6. The humus content of the soil varies from season to season.

The above facts clearly indicate that the main disturbing factors in the soil are its sandy nature and the low water content. Otherwise the soil is fairly rich in other mineral nutrients necessary for the growth and development of the vegetation.

Biotic Factors :

No interpretation of the vegetation can be complete without due consideration of the biotic factors. Man and animals destroy whatever little is there and thus devoid the area of its vegetation. They may operate directly or indirectly on the aerial parts of the plants or on their underground structures. Even the educated people have been seen paddling their cycles on the growing vegetation in the area during the rainy season and later. They thus trample the smaller plants without any sense of their importance. Children of the college servants also partake in this by playing on and uprooting the plants. The effect of the human factor is thus to interfere with the natural development of the vegetation and to throw it back to a more primitive stage.

Along with the man, the animals cause a considerable havoc to the vegetation. The goats and cattle are left loose after milking. Goats do a great deal of damage by eating up and killing all sorts of young plants, and pulling them up from the roots. Throughout the year, but specially during the first fortnight of the monsoon, it is a common sight to find on green vegetation stray herds of cattle wandering about and trying to pick up whatever they can. They graze close to the ground. Again the trampling done by goats and cattle is disastrous. There are some stray cattle who have no other means of subsistance than grazing.

During a favourable rainy season grazing may not entirely eliminate the vegetation, even though it is eaten off close to the ground. As the cold season progresses, and the growth of the herbaceous vegetation is checked, the effect of overgrazing becomes more and more evident. Annuals die under the combined hardships of the grazing and lack of protection. Only perennial grasses and a few other xerophytic herbs with strong perenating organs are able to survive.

Rats dig numerous holes in the soil for their habitation. In this way they make the soil loose and thus affect the water retaining capacity of the soil. According to the experiments conducted by Afforestation Department, Jodhpur, the rats are responsible for destroying many thousand maunds of seeds broadcast by them.

The ants bore holes through the soil and make crevices. As a result the soil is rendered loose. They collect a huge number of seeds, on which they as well as the birds feed, thus reducing their percentage number which would have otherwise germinated in the next favourable season. Moreover, some religious minded people feed the ant hills and holes and thus encourage devastations. The ants have a number of colonies in the area which have arterial connections.

The desert locust destroys the annuals and perennials both in the hopper and the adult stage. They devour the leaves and in extreme cases, even the bark of the plants, thereby leaving only the woody portion behind. The locust swarms are periodic. The common species are *Schiztocerca gregaria* Forskal and *Locusta migratoria* Linn.

The squirrels are another serious menace to the vegetation. They usually make the young seedlings as their food and eat away every possible young growth Thus they do not allow the vegetation to come up.

Root Habits of the Weeds :

Root systems of the weeds in the present study were of the three main types :

1. Deep root system with little lateral spread. The roots go 20–30 cms. deep.
2. Small surface root system penetrating to a maximum depth of 5–15 cms.
3. Shallow root system with considerable lateral spread.

These marked contrasts in the degree of ramification of the roots as they penetrate different soil strata are often to be attributed to differences in the richness of the soil.

Long deeply descending roots are characteristic of the sandy areas. The great depth is to be correlated to the deep soil moisture. These roots are feebly branched. The looseness of the soil makes the root penetration easier. Examples are *Gynandropsis pentapylla* DC. *Trianthema monogyna* L.; *Amaranthus viridis* L., *Tribulus terrestris*, L., *Heliotropium strigosum* L.; *Calotropis procera* R. Br.

In case of small surface root system the roots are short, spreading and richly branched. They are mostly found on the gravelly areas. Exmpales are *Euphorbia microphylla* ; *E. hirta* ; *Gynandropsis pentaphylla* DC. ; *Amaranthus viridis* ; *Phyllanthus niruri* ; *Evolvulus alsinoides*, *Cleome viscosa* etc.

Shallow root system develops usually in the soil whose surface remains moist due to the watering of the adjacent areas. The plants growing at those places have copiously branched roots forming dense clumps in many cases. Examples are *Eragrostis pilosa* Beauv ; *E. tenella* ; *Cyperus rotundus* L. ; *Fumaria parviflora* Lamk ; *Asphodelus tenuifolius* Cavan ; *Chenopodium album*, etc.

Histology of the weeds :

Anatomy of the common weeds of the area was carefully studied in order to find out the ecological features. They are as follows :

1. The epidermal cells have their outer walls convexly arched outwards and are usually cutinized. The thick cuticle helps in reducing the loss of water by transpiration. This is a very characteristic feature of most of the desert plants.
2. Stomata usually occur on lower surface of the leaves and are sunken in most of the cases.
3. Hairy covering was found in most of the cases. It forms a non-conducting screen against heat and the sunlight reflected from the sand. Moreover the hairs absorb moisture from the atmosphere.
4. Pericycle is composed of either a continuous ring or closely pressed group of stone cells or of bast fibres.
5. Weed usually form a composite hollow cylinder. Medullary rays are usually narrow.
6. Pith is usually formed of thin walled cells.

Important Morphological Features :

A morphological study of the various weeds showed the following features :—

1. General reduction of the transpiring suface and in some cases a complete loss of the leaves,

2. Reduction of the shoot in relation of the root.
3. Deep penetrating root systems.

From the morphological and anatomical study we find that the weeds have adapted themselves to the prevailing condition by the development of the xerophytic features.

Floristic Composition :

It is clear that the rainfall of the area is scanty, the percentage of the relative humidity low and temperature extreme. In addition is the dry sandy soil. These factors are hardly favourable for the luxuriant growth of the vegetation. Most of the plants in the area exhibit characteristic features of xerophytes.

On the basis of the source of available water, the entire vegetation can be divided into two groups. Those which depend upon the rain and those which depend upon the subterranean water retained in the deeper layers of the soil. To the first category belong the herbaceous annuals. They burst into an intensely active life of very short duration *viz* ; one to three months. These appear with the first shower, flower within a few days, set seeds and may disappear. The most common rainy season plants of the area are *Gynandropsis pentaphylla* DC. ; *Cleome viscosa* L ; *Portulaca oleracea* L ; *Trianthema monogyna* L ; *Tribulus terrestris* L ; *Aerua tomentosa* Forsk ; *Achyranthes aspera* Linn., *Boerhaavia diffusa* L ; *Euphorbia hirta* L ; *Phyllanthus niruri* ; *Mollungo nudicaulis* etc.

To the second category belong the perennials like *Prosopis spicigera* L ; *Salvadora persica* ; *Calotropis procera* R. Br. ; *Zizyphus jujuba* Lamk. *Z. rotundifolia* Lamk ; *Calligonum polygonoides* L., *Boerhaavia diffusa* L ; *Tribulus terrestris* L.

Taking into consideration the edaphic factors against the poor rainfall, the vegetation of the area can be divided into sand community and gravel community. The most common plants growing on the sand community are *Calotropis procera* ; *Indigophera argentea* ; *Crotalaria burhia* ; *Leptadenia spartium* ; *Aerua tomentosa* ; *Panicum* spp., *Erogrostis* spp ; *Polygala* spp. *Calligonum polygonoides.* They have woody, deeply descending tap roots. Besides the above plants several other herbs, shrubs and stunted trees like species of *Zizyphus* ; *Parkinsonia* ; *Acacia* ; *Prosopis* and others form the component of the vegetation. *Prosopis spicigera* is the most common tree of the area and desert as a whole.

Ecologically the gravel area is unsuitable for the vegetation since it has got a very poor capacity to hold water. But plants like *Phyllanthus niruri* L ; *Argemone mexicana* ; *Boerhaavia diffusa* L ; *Mollugo nudicaulis* L ; *Tribulus terrestris* L ; *Heliotropium strigosum* etc. form the typical components of the community. A few plants which are common in the sand community also develop in gravel. Examples are *Gynandropsis pentaphylla* DC. ; *Trianthema monogyna* L ; *Calotropis procera* R. Br. ; *Crotalaria burhia* and a few other grasses.

Frequency of the plants was gradually reduced with the decrease in the amount of rainfall. The succession of the plants may be represented as follows :

Rainy Season

Early Plants	Late Plants
Amaranthus viridis L.,	*Boerhaavia diffusa* L ;
Gynandropis pentaphylla DC.	*Phyllanthus niruri* L.
Tribuls terrestris L.	*Heliotropium strigosum* Willd.
Trianthema monogyna L.	
Cynodon dactylon Pers.	

Several plant communities were observed in the area. The chief association are :

I. *Gynandropsis—Tribulus* association : The associates are as follows :

1. *Gynandropsis pentaphylla* DC.	d
2. *Tribulus terrestris* L.	Co.d
3. *Boerhaavia diffusa* L.	c
4. *Trianthema monogyna* L.	c
5. *Amaranthus viridis* L.	c
6. *Heliotropium strigosum* Willd.	f

II. *Gynandropsis—Trianthoma* association : The associated plants are as follows :

1. *Gynandropsis pentaphylla* DC.	d
2. *Trianthema monogyna* L.	Co.d
3. *Boerhaavia diffusa* L.	c
4. *Amaranthus viridis* L.	c
5. *Heliotropium strigosum* Willd.	r
6. *Indigofera argentea*	r
7. *Digera arvensis* Forsk.	f
8. *Tribulus terrestris* L.	f
9. *Celosia argentea* L.	f

III. *Gynandropsis—Amaranthus* association : The associated plants are as follows :

1. *Gynandropsis pentaphylla* Dc.	d
2. *Amaranthus viridis* L.	Co.d
3. *Trianthema monogyna* L.	c
4. *Mollugo nudicaulis* L.	c
5. *Cynodon dactylon* Pers.	c
6. *Phyllanthus niruri* L.	r
7. *Digera arvensis* Forsk.	f
8. *Achyranthes aspera*	f

IV. *Calotropis—Leptadenia* association : The associates are as follows :

1. *Calotropis procera* R. Br.	d
2. *Leptadenia spartium* Wight.	Co.d
3. *Crotalaria burhia* Hamilt.	c
4. *Aerua tomentosa* Forsk.	c
5. *Eragrostis* sp.	r

V. *Boerhaavia—Tribulus* association : The associated plants are as follows :

1. *Boerhaavia diffusa* L.	d
2. *Tribulus terrestris* L.	c
3. *Phyllanthus niruri* L.	c
4. *Mollugo nudicaulis* L.	f
5. *Gynandropis pentaphylla* DC.	r

VI. Pure associations of *Argemone mexicana* were also observed.

A list of weeds found growing in the area under study is given below. It is not claimed to be complete :

Name of the plants	*Frequency*	*Family*
1. *Calligonum polygonoides* L.	r	Polygonaceae
2. *Polygonum plebejum* R. Br.	c	,,
3. *Argemone mexicana* L.	c	Papaveraceae
4. *Chenopodium album* L.	c	Chenopodiaceae
5. *Portulaca oleraceae* L.	c	Portulacaceae
6. *Celosia argentea* L.	c	Amarantaceae
7. *Digera arvensis* Forsk.	c	,,
8. *Amaranthus viridis* L.	c	,,
9. *A. blitum* L.	c	,,
10. *Aerua tomentosa* Forsk.	f	,,
11. *Achyranthes aspera* L.	f	,,
12. *Boerhaavia diffusa* L.	c	Nyctaginaceae
13. *Trianthema monogyna* L.	d	Aizoaceae
14. *T. pentandra* L.	f	,,
15. *Mollugo nudicaulis* Lamk.	f	,,
16. *M. cerviana* Serine	f	,,
17. *Cleome viscosa* L.	f	Capparidaceae
18. *Gynandropsis pentaphylla* DC.	d	,,
19. *Capsella bursapastoris* Manch.	f	Cruciferae
20. *Lepidium sativum*	r	,,
21. *Crotalaria burhia* Hamilt.	f	Papilionaceae
22. *Indigofera argentea*	c	,,
23. *Tephrosia purpurea* Pers.	c	,,
24. *Prosopis julifera* DC.	c	Mimosaceae
25. *Tribulus terrestris* L.	Co.d	Zygophyllaceae
26. *Euphorbia hirta* L.	c	Euphorbiaceae
27. *Phyllanthus niruri* L.	f	,,
28. *Calotropis procera* R. Br.	c	Asclepiadaceae
29. *C. gigantea* Br.	f	,,

Name of the plants	*Frequency*	*Family*
30. *Leptadenia spartium* Wight.	f	,,
31. *Convolvulus arvensis* L.	f	Convolvulaceae
32. *Evolvulus alsinoides* L.	f	,,
33. *Heliotropium strigosum* Willd.	f	Boraginaceae
34. *Leucas aspera* Spreng.	f	Labiateae
35. *Solanum xanthocarpum* Schrad.	f	Solanaceae
36. *Datura alba* Vis.	f	,,
37. *Celsia coromandaliana* Vahl.	f	Scrophulariaceae
38. *Lepidogathis trinervis* Nees.	f	Acanthaceae
39. *Peristrophe bicalyculata* Nees.	c	,,
40. *Citrullus colocynthis*	f	Cucurbitaceae
41. *Senecio graliani* Hook.	c	Compositeae
42. *Asphodelus tenuifolius* Car.	c	Liliaceae
43. *Chloris tennella* Roxb.	f	Gramineae
44. *C. virgata* Se.	f	,,
45. *Aristida adscensionis* L.	c	,,
46. *Digitaria sanguinalis* Scop.	c	,,
47. *Eleusine indica* Gaertn.	f	,,
48. *Eragrostis ciliaria* Link.	f	,,
49. *E. Tenella* Beaur.	f	,,
50. *Panicum fluitans* Retz.	r	,,
51. *Cenchrus catharticus* DC.	c	,,
52. *Cynodon dactylon* Pers.	d	,,
53. *Setaria glauca* Beauv.	r	,,
54. *Cyperus rotundus* L.	f	Cyperaceae

d : dominant, Co.d. : Co-dominant c : common, f : frequent r : rare

Thus 54 weeds belonging to 25 families were found. The commonest and most successful weeds belong to Capparidaceae, Aizoaceae, Nyctaginaceae, Amarantaceae, Leguminoseae, Zygophyllaceae, Euphorbiaceae and Gramineae.

Weeds and Their Role in the Immobilization of the Desert :

It is a general practice to condemn weeds because they do a considerable harm to the crops, vegetables, ornamental plants, animals and the human being. Their control is an interesting study particularly in the places where they commit nuisance as said above.

In our cases, however, it is not a great problem, as we want to grow weeds and find out which of these would grow under the adverse conditions prevailing in the area. They are among the pioneer plants to remove the scars made on the ground by the biotic factors. Weeds like *Tephrosia purpurea* Pers. and *Indigofera argentea* are very effective in holding the soil and resist erosion. Thus they may prove of inestimable value not only in holding the march of the desert but in

reclaiming the sandy deserts for the ultimate afforestation. *Cyperus* spp. act as very good and binders. Most suited weeds whose spread may be encouraged are *Gynandropis pentaphylla* DC. *Trianthoma monogyna* L. ; *Prosopis julifera* DC. ; *Amaranthus* spp. ; *Boerhaavia diffusa, Indigofera argentea* ; *Aerua tomentosa* and *Tephrosia purpurea.* These weeds may aid in the afforestation of the desert, area, provided there is no water problem.

SUMMARY

Ecological studies of the weeds were carried out in the year 1954–55 to find out some useful weeds which may prove useful in binding the loose soil. Ecological factors affecting the weed growth have been discussed thoroughly. In determining the vegetation, the quadrat method was adopted as a result of which frequency of species growing in the area at different places and also interdependence between various plant species was found out.

Physical and chemical soil analysis was done, the result of which has been mentioned. The limiting factors in the development of the vegetation are water content, humus content and percentage of water soluble salts in the soil.

Vegetation from the seasonal point of view has been studied and a list of weeds found in the area given. The root system of weeds was of a considerable interest and hence their special study was made.

Anatomical studies of the different vegetative organs have shown that most of the weeds in the area possess xerophytic features.

A few weeds have been suggested whose spread may be encouraged as an aid in the afforestation of the desert area.

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VEGETATION OF YEDSHI FOREST AT RAMLING IN MAHARASHTRA

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The botany and ecology of the forests of most parts of western India have not been fully studied. Puri and Jain (1959) described the flora and vegetation of the Deccan Trap country in considerable detail. While describing the botany of western India, particularly of the arid and semiarid zones Puri and Jain (1961) pointed out that the semiarid tract of western India is an almost continuous region from eastern Rajasthan through Madhya Bharat, Khandesh and eastern strip of Maharashtra to eastern parts of Mysore and Kerala (Plate 1, Fig. 1). This entire tract has been and even now is under heavy biotic pressure. The present poor vegetation of this zone is greatly due to this factor.

Several selected localities in this zone are being observed intensively to study the ecological conditions and succession (Puri and Wadhwa, 1959). The present study, therefore, was a part of larger programme of work on western Indian vegetation.

This study was made at Yedshi forest at Ramling which is one of the many typical representatives of the semiarid tract.

Yedshi forests are situated in northeast of Sholapur district on 18°13'N. latitude and 76°E. longitude. The boundary of Osmanabad district of Andhra Pradesh lies just adjacent to these forests. The place is approachable by train from Kurduwadi on Miraj-Latur branch line.

Climate—The mean temperature during summer is about 40°C and about 2°C during winter.

The entire semiarid tract of western India is in the 'shadow' of one or the other hill range of western India such as the Aravallis and the long chain of Western ghats, and receives poor rainfall. The annual rainfall at Ramling is approximately 650 mm.

Detailed rainfall and temperature data for Ramling are not available but data for Barsi (about 25 km. in south-west of Ramling) and Sholapur (60 km. south of Ramling) are available and are represented by rainfall patterns and climograph (Plate I, Fig. 2, 3 and 4. These patterns closely resemble the patterns from other places in the semiarid tract.

Geology and Soil—The area is a part of the Deccan Trap and is rather uneven and mountainous. The soil is generally shallow on hill tops, deeper on slopes and valleys. It is either greyish brown or red and generally coarse and gravelly.

Topography—The area is hilly with low hills forming small ridges. The general altitude of the area is about 700 metres above sea level, and the hills rise gradually about 100 metres above the general level of the surrounding area. The slopes are very gradual. The Railway Bungalow (which is the only but a decent arrange-

PLATE I

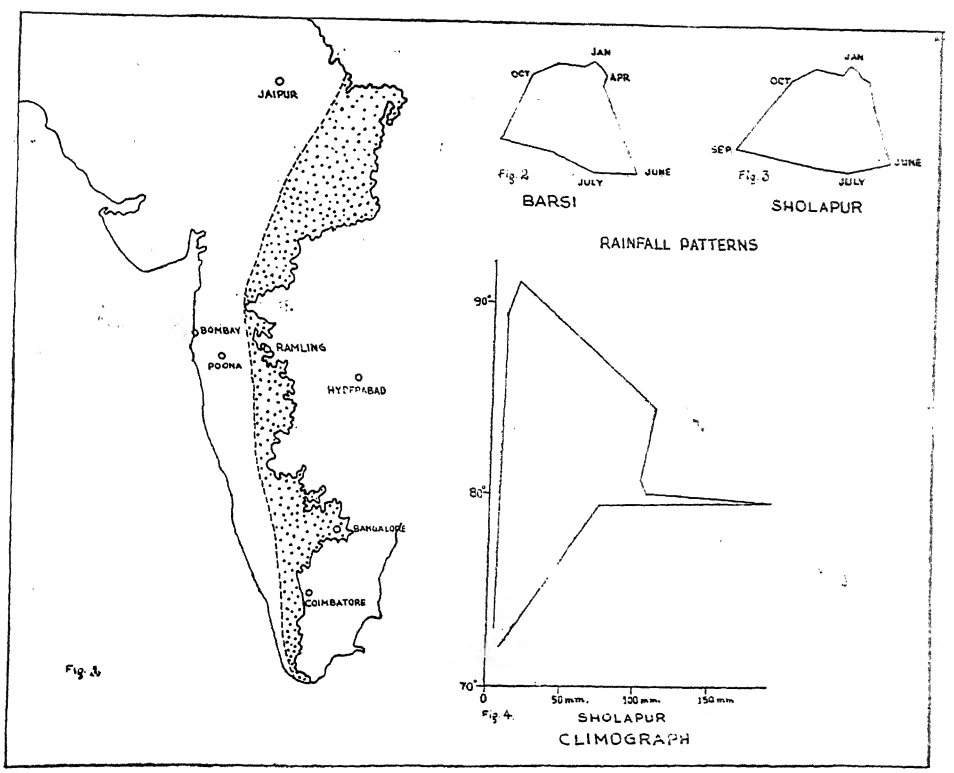

Fig. 1. Map of western India showing location of Ra nling and the general semiarid tract running north-south (Shaded)
Fig. 2. Rainfall pattern of Barsi (rainfall, 692 mm.)
Fig. 3. Rainfall pattern of Sholapur (rainfall, 681 mm.).
Fig. 4. Climograph of Sholapur.

Ph. 1. A general view of the barren hilltops and undulated land at Ramling ; a *Euphorbia nivulia* clump in foreground right. (Ph. Jain)

Ph. 3. *Boswellia serrata* tree with *Apluda.* grass in undergrowth. (Ph. Jain).

Ph. 2. *Heteropogon contortus*, a common grass in Yedshi forest. (Ph. Jain)

ment of stay in this place) is located at the top of the highest hillock, and from this point a panoramic view of undulating land (Plate II, Photo : 1) is gained of the surrounding area in northeast, east and southeast.

The river Bhogawati, a tributary of river Sina, flows southwards through the area.

Biotic factors—The area is fairly barren and devoid of vegetation to attract any further significant devastation. It has been open to grazing and lopping by local inhabitants.

Vegetation—Botanical collections were made in this area in winters and in rainy season and the plants were preserved and identified. The vegetation was also studied by running a number of transects on different hills, and making quadrat records. The data obtained during these studies is summarised in Table 1. The frequency of occurrence expressed in percentages of the quadrat studied is given for more common species of trees, shrubs and grasses.

TABLE 1

Locality	Ramling (Maharashtra) Yedshi forest	Ramling (Maharashtra) Yedshi forest
Rock, gelology, soil	Trap rock, basalt shallow soil	Trap rock, basaltic, shallow soil
Topography, slope	Low hills, NORTH slope	Low hill, SOUTH slope
Particulars of quadrats	23 quadrats from three transects, diam. 5 m.	10 quadrats diam. 5 m.
Species	Percentage of quadrats	Percentage of quadrats
Acacia chundra Willd.	28	70
Anogeissus latifolia Wall.	64	70
Boswellia serrata Roxb.	8	50
Buchanania lanzan Spreng.	4	10
Carissa congesta Wt.	12	..
Dalbergia paniculata Roxb.	12	..
Diospyros sp.	16	20
Gardenia gummifera Linn. f.	48	40
Grewia tilaefolia Vahl.	28	10
Gymnosporia spinosa Fiori.	44	60
Ixora arborea Roxb.	36	10
Lannea coromandelica Merr.	20	20
Meyna laxiflora Robyns.	8	10

Species	Percentage of quadrats	Percentage of quadrats
Mimosa hamata Willd.	44	90
Morinda tinctoria Roxb.	8	10
Randia sp.	20	20
Stereospermum personatum Chatt.	. .	20
Tectona grandis Linn. f.	8	10
Terminalia crenulata Roth.	4	10
Zizyphus sp.	29	20
Grasses		
Apluda mutica Linn.	24	20
Arundinella sp.	20	10
Chrysopogon sp.	20	60
Heteropogon contortus Beauv. ex R. and S.	60	80
Iseilema sp.	24	60
Themeda sp.	4	20

The forests are generally of Champion's 'Tropical Thorn Forest Type'. Puri (1960 p. *247* and *250*) and Puri and Jain (1958, 1960) described the Thorn forests of Deccan Trap from Dhond, Walhe etc. In all these localities as also in the locality presently studied the climate and soil can support a better vegetation, but the biotic pressure keeps the vegetation arrested only at this stage.

Some patches of dry deciduous forests occur on slopes. They tend even to progress to moist deciduous type in the valleys and moist situations along nalas as is evident by the presence of *Syzygium cumini* Skeels, *Terminalia crenulata* Roth. *Ficus* spp., etc. The upper slopes, plain country and hill tops are covered only by scrub forest in various degraded stages. Some hill tops have only grasslands with sparsely scattered shrubs or sporadically growing malformed trees.

The deciduous forests are composed chiefly of *Anogeissus latifolia* Wall., *Boswellia serrata* Roxb., *Grewia tilaefolia* Vahl., *Ixora arborea* Sm. and *Lannea coromandelica* Merr.

Gardenia gummifera Linn. f. is a small tree or shrub common on lower slopes. Commonest shrubs and small trees are *Acacia chundra* Willd., *Gymnosporia spinosa* Fiori and *Mimosa hamata* Willd.

Combretum ovalifolium Roxb. is a robust climber and is common. Other common climbers are *Cocculus hirsutus* Diels., *Cryptolepis buchanani* R. and S., *Mucuna prurita* Hook. and *Tinospora cordifolia* Miers.

The common grasses in the area are *Apluda mutica* Linn., *Chrysopogon fulvus* Chiov., *Heteropogon contortus* R. and S. (Plate II, Photo : 2), *Iseilema* sp. and *Themeda* sp.

Observations on different slopes of the hills do not indicate any significant differences in vegetation, probably due to uniform biotic pressure. Some species are

slightly more common on northern slopes such as *Grewia tilaefolia* Vahl and *Ixora arborea* Sm., whereas *Boswellia serrata* Roxb. (Plate II, Photo : 3), *Acacia chundra* Willd. and *Mimosa hamata* Willd. are more common on southern slopes of hills.

The dominant community is *Anogeissus-Acacia* in tree layer and *Mimosa-Gymnosporia-Gardenia* community in shrub layer.

Trees of *Albizzia odoratissima* Benth., *Bridelia retusa* Spreng., *Cassia fistula* Linn., *Dolichandrone falcata* Seem., *Ficus* sp., *Santalum album* Linn., *Terminalia arjuna* W. and A., *Terminalia bellerica* Roxb. and *Terminalia crenulata* Roth occasionally occur on the foot of hills and in valleys or along moist nala banks, on alluvium.

Several other tree and shrub species sporadically grow in these forests but their frequency is low and they do not form conspicuous features of vegetation. They have been included in Table II where available local names for some common forest species have been given.

TABLE II

Local common names of plants

Botanical names (alphabetical)	Local names
Acacia arabica	Babul
A. chundra	Khair
A. leucophloea	Hivar
Agave sisalana	Ghaypat
Albizzia odoratissima	Kala Siris
Anogeissus latifolia	Dhaura
Azadirachta indica	Nim
Bauhinia racemosa	Apta
Boswellia serrata	Salai
Buchanania lanzan	Char
Butea monosperma	Palas
Capparis decidua	Neptar
C. divaricata	Tarati
Carissa congesta	Karonda
Cordia dichotoma	Bhokar
Dalbergia paniculata	Sondera
D. sissoo	Sisu
Diospyros melanoxylon	Tembuni
Euphorbia nivulia	Nivdung
Gardenia gummifera	Dikamali
Grewia tilaefolia	Dhaman
Gymnosporia spinosa	Haikal
Ixora arborea	Lokhandi
Lannea coromandelica	Moja, Shembat

Botanical names	Local names
Meyna laxiflora	Alu
Morinda tinctoria	Al
Randia sp.	Gera
Rhus mysorensis	Amond
Santalum album	Chandan
Syzygium cumini	Jambul
Tectona grandis	Sakh
Zizyphus sp.	Nanbor

The Forest Department has taken up large scale afforestation of these hills. An area of 1577 acres has been taken under plantations, (Khisty, 1961). Their programme includes planting of the following species :

Acacia chundra Willd., *Albizzia lebbeck* Benth., *Annona squamosa* Linn., *Azadirachta indica* A. Juss., *Bauhinia racemosa* Lam., *Dalbergia sissoo* Roxb., *Feronia limonia* Swingle, *Grewia tilaefolia* Vahl., *Hardwickia binata* Roxb., *Prosopis juliflora* DC., *Salmalia malabarica* Schott. and Endl., *Tectona grandis* Linn. and *Terminalia crenulata* Roth.

Gliricidia sepium has been found to be very successful in Barshi area.

The study of the area indicates that the species chosen by the Forest Department should establish in the area very well as many of them are indigenous to the area and even regenerate themselves.

Agave species are being planted on hedges of plantations to keep away cattle. In order to provide feeding stuff for the cattle of the area following plants have been suggested for growing outside these fences :

Indigofera pulchella Roxb., *Sesbania bispinosa* Fawcett and Rendle, *Sesbania grandiflora* Pers. and *Tephrosia purpurea* Pers.

In order to check erosion on hill slopes the forest department has constructed gully plugs and check dams in gullies and nalas. The plugs and dams consist of dry rubble walls about 30 cm. high. *Agave* has been planted on the bunds of these small dams.

The area has received the attention of the Forest Department at opportune time and the vegetation which has been degraded to a poor shrub stage is now bound to be replaced by good deciduous forests.

Ramling is one of the common places in the Deccan Trap country where vegetation presents such features due to adverse biotic pressure of population. The community studied is bio-edaphic disclimax type and is not likely to progress any further to the moist deciduous forest type.

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THE EFFECT OF SOME WEEDICIDES IN THE ERADICATION OF WATER HYACINTH (*EICHORNIA CRASSIPES*)

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INTRODUCTION

Water hyacinth (*Eichorina crassipes*) locally known as *Jalkumbhi* has spread over extensive areas throughout Uttar Pradesh. It grows profusely in tanks, ponds, lakes and other reservoirs of standing and stagnant waters. Its presence affects the cultivation of important crops like *singhara* (*Trapa bispinosa*), *kamalgatta* (commonly called lotus, *Nilumbium speciosum*), boro paddy, etc, by blocking and barricading the water-ways and irrigation channels ; thus indirectly affecting the crop production. It has been observed that this weed makes the fish farming impracticable. *Inter-alia* the greatest danger to the man and cattle lies in rendering the infested water unsuitable for drinking purposes. Nevertheless there are great possibilities of ultilising this weed as a manure for which systematic and detailed research investigations are needed.

MATERIAL AND METHOD

During 1957 laboratory trials were conducted at Kanpur with various concentrations of Fernoxone ^{X}, sodium salt of 2, 4-D (Dichlorophenoxy-acetic acid) and Pentachelorophenol^{Y}, to determine the minimum strength required for the effective control of this weed. In these trials fresh water hyacinth plants were collected from nearby pond and lake. These were transferred in large tubs containing sufficient water in the laboratory. The water in the tubs was regularly changed to avoid stagnation.

The concentrations of Fernoxone ^{X}, tested were 1 part of the weedicide mixed in 600, 640, 700, 800, 900 and 1000 parts of water by weight, applied @ 150 gallons spray per acre surface area. The observations are enumerated in the following Table I :

TABLE I

Ratio of Fernoxone in water	Observations
1 : 600	Plants dried out completely after 4 days of the application.
1 : 640 1 : 700 1 : 800	Plants dried out completely by the 5th day of the application.
1 : 800	Plants dried out completely within 6 days of the application.
1 : 900 1 : 1000	Complete driage of the leaves not achieved till 6th day when the observations were concluded.

From the above table it is concluded that a spray containing 1 part of Fernoxone in 600 to 800 parts of water is sufficiently toxic to kill this weed within 4 to 6 days of the application.

The concentrations of Pentachlorophenol tested were 0·0125%, 0·025%, 0·05%, 0·1%, 0·12%, 0·13%, 0·14%, 0·16%, 0·2%, 0·25%, 0·5%, 1·0%, 1·5% and 2·0% applied @ 150 gallons spray per acre surface area. The results are summarised in Table II:

TABLE II

Percentage of PCP tested	Ratio of 12% PCP in water	Observations
2·0 1·5 1·0 0·75 0·5 0·25	1 : 5 1 : 7 1 : 11 1 : 15 1 : 23 1 : 47	Plants dried out completely within 24–48 hours of the application.
0·2 0·16 0·14 0·13 0·12	1 : 59 1 : 74 1 : 85 1 : 91 1 : 99	Plants dried out completely within 48 hours of the application.
0·1	1 : 119	Plants died within 48 hours with low mortality of the leaves.
0·05	1 : 239	Leaves turned slightly brownish but plants survived.
0·025 0·0125	1 : 479 1 : 959	Plants remained healthy.
Control (No Treatment)		Plants survived throughout the experiment.

The results as summarised in Table II show that 0·12% Pentachlorophenol spray was sufficiently toxic to the weed which dried out within 48 hours of its application.

The application of sprays of any of two weedicides, mentioned above, can successfully be carried out on the plants over infested sources by means of a power sprayer mounted along with the spraying accessories on a boat. An area of about 8–10 acres can be effectively controlled in a day.

Economics : The cost of 2, $^{4\text{-}D}$ (Fernoxone) for the successful control of water hyacinth in an acre will be about Rs. 7·00 and Rs. 5·50 for concentration of 1 : 600 and 800, respectively and Rs. 18 for 0·12% concentration of PCP.

Note.—X–Fernoxone or the Sodium salt of 2, $^{4\text{-}D}$ is marketted by the Imperial Chemical Industries (India) Private Ltd., 18, Strand Road, Calcutta–1.

Y–Pentachlorophenol 12% is marketted by Burmah Shell, New Delhi.

NOTE ON LIFE-HISTORY AND CONTROL OF SANN HEMP HAIRY CATERPILLAR, *UTETHEISA PULCHELLA* LINN.

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Utethesia pulchella Linn., belongs to the Order Lepidoptera ; Sub-order Heterocera ; Family Arctidae and Sub-family Arctinae.

Larval damage :

It is one of the most serious and specific pests on Sann hemp. *crotalaria juncea.* In the earlier stages of the growth of the crop it destroys the leaves as a foliage feeder, while in the later stages *i.e.*, after pod formation it acts as a pod borer. After boring a hole in the pod the seeds are eaten up leaving the empty pods which dry afterwards either on the plant or fall down over the ground. Thus it damages the seeds as well as prevents the growth of the plants. It has been observed that the caterpillars are slightly migratory in nature.

Adult moths :

The adult moths are diurnal and also attracted towards milky light during night. The adult is a medium sized moth with a wing expanse of $1\frac{1}{4}''$. Forewings are dirty-white in colour spotted with numerous small red and black dots. The hind wings bear irregular black markings on the posterior margin and small bracket shaped mark near the centre.

Life History :

The preoviposition period varies from one to two days. The female moth lays spherical shining white eggs which are slightly depressed at the base-either during morning or evening and also at night. After some time the colour of the eggs changes from white to pale-yellow and finally yellow. Eggs are generally laid on the lower surface of the leaves either singly or in batches of 2–5 eggs but sometimes they are also found on the apical leaves, buds, flowers and young pods. A single female lays 300–400 eggs in her life time.

Larva :

Eggs hatch in 3–4 days and the tiny hairy larva with orange coloured head measures about 2 m.m. in length. The colour of the caterpillar is dark gray with faint pale lines on the dorsal side. It first feeds on the epidermis of the leaves and later on begins chewing them. The larval period varies from 11–20 days during July to November. Fully grown larva is velvety black in colour and possesses reddish brown head. The back is covered with blotchy spots on the middle and sides. Full fed larva measures 2–2·25 c.m. in length. The larva moults five times before it becomes fully grown.

Pupa :

The pupation takes place either on the plant or the surface of the soil l joining 2–3 leaves in a silken cocoon. The pupa is brownish black in colour an measures about ½" in length. The pupal period lasts usually for 5–7 days durir July to September. The period of complete life cycle of this pest varies fro 3–4 weeks.

CONTROL

With a view to evolve suitable method of its control an insecticidal tri was conducted at Arazilines Farm, Varanasi, during Kharif 1960. The following treatments were applied :

1. Spraying the crop with 0·25% DDT suspension @ 60 gallons per acre.
2. Dusting the crop with 10% DDT dust @ 20 lbs. per acre.
3. Spraying the crop with 0·25% BHC suspension @ 60 gallons per acre.
4. Spraying the crop with 0·03% diazinon @ 60 gallons per acre.
5. Dusting the crop with 10% BHC dust @ 20 lbs. per acre.
6. Dusting the crop with 5% BHC dust @ 20 lbs. per acre.
7. Control (Untreated).

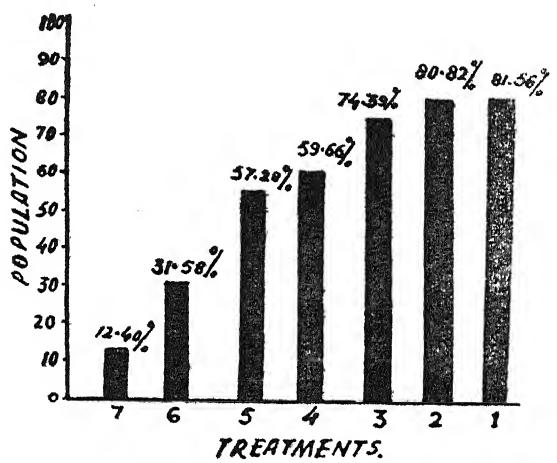
Observations were taken by counting the number of caterpillars present in 1(plants at various places of the experimental plot both before and 24, 48 and 72 hours after the application of the treatments.

From the result of this trial which is also being represented in a histogram below, it is concluded that spraying the crop with 0·25% DDT (Suspension) @ 60 gallons per acre proved to be the best treatment against this pest closely followed by dusting the crop with 10% DDT @ 20 lbs. per acre. These treatments have given a reduction of 81·56% and 80·82% respectively in the population of the pest.

STATISTICAL ANALYSIS

The results of these trials were also statistically analysed and were found to be highly significant at 0·1% level of probability. A significant decrease in the mean number of caterpillars than control was noticed in the treatments Nos. 1, 2 and 3 respectively.

PERCENTAGE REDUCTION IN THE POPULATION OF THE HAIRY CATERPILLAR OF SANAI, *UTETHEISA PULCHELLA* LINN.



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